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THE HYPOPYGIUM OF THE TIPULIDÆ.

BY ROBERT E. SNODGRASS, Stanford University, California.

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INTRODUCTION.

The material from which this paper has been prepared is a large collection of Tipulidæ, belonging to the Biology Department of the Washington Agricultural College. The collection was classified and arranged by Mr. R. W. Doane, formerly assistant entomologist at the College and Experiment Station, and contains the types of Mr. Doane's new species of Tipulidæ published in several papers. The names used in the present paper are according to Mr. Doane's identifications.

In two other papers* on Dipteran hypopygiums, the writer has restricted the application of the word *hypopygium* to the ninth abdominal segment only. The same usage will be adhered to in this

* Psyche, vol. ix, pp. 339, 400.—The Inveiled Hypopygium of *Dasyllis* and *Laphria*; and Proc. Cal. Acad. Sci. (MS).—The Hypopygium of the Dolichopodidæ.

paper. The word has generally been used to signify the entire posterior enlargement of the male abdomen. Since, however, this is an extremely variable structure, and since, also, in many insects there is no enlargement of the abdomen, the word used in this fashion must have a very indefinite meaning, or none at all when the male genital parts do not form an enlargement. "The hypopygium" would, within the same genus, in some cases mean one segment and in other cases mean several segments. Within the same family some genera would have large hypopygia and others none at all. Hence, it seems best, in order to give the term a definite significance, to make it mean the genital segment of the male, *i. e.*, the segment that carries the intromittent and clasping organs. This is, in all insects, the ninth segment of the abdomen. The etymology of the word is such that the derivational meaning may be disregarded.

The general shape of the hypopygium in the family Tipulidae is that of a cup opening posteriorly. The cavity of the cup is the *genital chamber*. It is produced simply by the invagination of the posterior face of the segment. This carries into the depression the tenth segment, which morphologically terminates the abdomen. The tenth segment, bearing the anus at its end, is reduced to a small membranous tube, or to a simple prominence, arising from the upper part of the anterior wall of the genital chamber. It seldom projects much beyond the hypopygium.

Attached to the posterior rim of the hypopygium are from one to three lobe-like appendages on each side. These are called the *apical appendages*. The body of the segment is made up of four plates, one dorsal, two lateral and one ventral. It is evident that the dorsal plate is simply the tergum and that the ventral plate is the sternum of the segment. The lateral plates vary greatly in position, but in two groups of genera, from each of which a line of more specialized genera may be derived, these plates occupy a typically pleural position. That is, they extend along the entire length of the segment, one on each side, between the tergum and the sternum. On this account they will be given here the name of *pleura*. This name is adopted, however, simply on a basis of analogy. But probably many names applied to different parts of the external anatomy of insects have no basis in homology. In our present ignorance of the external homologies of insects, there is no need to make a new word when "pleural" may refer to any plate intervening on the side of the segment between the tergum and the sternum.

In the lower genera, as just stated, the pleura lie in their normal position, one on each side of the segment, between the tergum and the sternum. In other genera, however, they may be either exerted upon the posterior rim of the segment, or form a small plate set into the posterior rim, or they may be absent entirely.

In the genus *Tipula* the pleura are never very conspicuous and are in many species entirely absent. Westhoff, in his paper on the hypopygium of *Tipula*,* almost entirely overlooks them. He regards the hypopygium as being formed of both the eighth and the ninth segments of the abdomen, and applies the following names to the different parts: the eighth tergum he calls the *lamella basalis supera*, the eighth sternum the *lamella basalis infera*, the ninth tergum the *lamella terminalis supera*, and the ninth sternum the *lamella terminalis infera*. But what is the use of employing such long and cumbrous terms when we already have the shorter names of *eighth tergum*, *eighth sternum*, etc. ?

In the lower genera the penis arises from the floor of the genital chamber and projects straight backward as a slender rod. In the genera of the Tipulina the base is carried up the anterior, and on to the dorsal, wall of the chamber. The penis in this case extends in a large curve down the anterior wall and then posteriorly along the floor of the genital chamber, its terminal part retaining the original position. The basal part in these forms is greatly swollen, forming a hemispherical vesicle. This is the *vesicula centralis* of Dufour. This name is used also by Westhoff, and in its anglicized form of *central vesicle* is employed in this paper.

The terminal part of the penis is in all cases protected by a guard. This has typically the form of two longitudinal plates set close together and on edge, projecting caudally from their origin on the floor of the genital chamber, and having their lower edges united by membrane. Numerous modifications of, and departures from, this typical form occur. The guard may be a solid cylindrical or plate like structure, with simply a longitudinal groove above to accommodate the penis, or it may be a hollow cylinder or tube entirely inclosing the penis within it. It is called by Westhoff the *adminiculum*.

In most of the lower species there project backward from the an-

* Westhoff, Friedrich, Ueber den Bau des Hypopygiums der Gattung *Tipula* Meigen, Inaug-Diss., Münster, 1882.

terior wall of the genital chamber, just above the guard of the penis, two elongate, free, chitinous rods. Each of these is very commonly forked. The word *gonapophyses* has been used by various describers of insect anatomy to designate four free rods that arise from the wall of the genital chamber, two above and two below the base of the penis, and project backward within the chamber. The application of the name "gonapophyses" to these rods is, very likely, a misnomer from the standpoint of homology. However, since it has been so used the writer will not here attempt to use a new word.

The guard of the penis is, as already stated, very often a solid structure with simply a lengthwise groove above; but, in a great many cases, it consists of two slender plates set on edge side by side and united by membrane along their lower margins. This structure would suggest that it may have been formed from two plate-like processes, extending backward from beneath the penis, whose lower edges became connected by membrane. In this case there would have originally been a pair of processes projecting caudally above the penis and another pair below it. This would be exactly the condition that exists in many forms of *Diptera*, *e.g.* in the *Muscidæ*. Hence, we can imagine, at least, that the guard of the penis and the two gonapophyses of the *Tipulidæ* represent the four gonapophyses of some other families. For this reason the *Tipulid* gonapophyses will be referred to in this paper as the posterior or second gonapophyses. The simple relationship of gonapophyses, penis and guard is seen best in the *Tipulid* genera below the group *Tipulina*, where the penis is a short, straight, rod-like tube.

As will be seen from the specific descriptions given beyond, and in the conclusion at the end of this paper, the structure of the hypopygium affords a good basis for determining not only the relationships of the larger groups of the family to one another, but also that of genera within the groups and of species in the genera. Furthermore, the minor features of the hypopygium, and especially the shape of the apical appendages, make most excellent specific characters. In the collection of *Tipulidæ*, from which this paper is prepared, a large number of specimens of the genus *Antocha* were placed together and labelled *A. opalisans*. Externally they are all very similar, except that some (Pl. VIII, fig. 5) have the pleural plates a little larger than others. However, it was found that in the former the guard of the penis has the form shown in fig. 8, while in

the latter that represented by fig. 6. Hence there were here confused two decidedly distinct species.

The objection to using hypopygial characters in specific descriptions is that the characters are hard to get at, and that their study involves the mutilation of specimens. When studying a dried specimen, one must break off the end of the abdomen, boil it in water until soft, and then dissect under a simple microscope and examine some parts under a compound microscope. Drawings must be made of all the parts, for differences are often such that descriptions alone would be inadequate. Here another difficulty arises, for the same parts often have very different appearances when placed in but slightly different positions. Yet the specific differences are in these parts so strongly and definitely marked that their study would certainly repay the expenditure of a great deal of time and patience. A specimen having the end of the abdomen broken off is worth just as much as an un mutilated specimen, which, by its very perfection, forbids the student any knowledge of its structure. If drawings and descriptions are made of the removed parts, then the mutilated specimen has certainly done more for science than the perfect one ever can do.

Genus **ANTOCHA.**

The structure of the hypopygium is undoubtedly more primitive in this genus than in any other examined by the writer. Other genera, such as *Rhamphidia* and *Dicranoptycha* of the group Limnobina Anomala, which is Osten Sacken's Section II of the Tipulidæ, do not show this simplicity of structure. The hypopygium of *Antocha* is even more simple than in the genera of Osten Sacken's Section I—the *Limnobina*; hence it is here described first.

Antocha opalizans O. S. (Pl. VIII, figs. 5, 8. 11).

Abdomen slender, hypopygium scarcely forming an enlargement. Eighth segment very simple; tergum and sternum subequal, forming a simple ring widest on the middle of the sides (fig. 5, viii).

The hypopygium is of primitive form, consisting of a tergal plate above, a sternal plate below, and of a large pleural plate on each side between the tergum and sternum (fig. 5, ix, *t*, *p*, *s*). The posterior face of the segment is deeply concave, forming a cup-shaped cavity, the *genital chamber*. In it are situated the penis and its guard, the gonapophyses, and the rudimentary tenth segment.

The tergum of the hypopygium is a triangular plate, with the apex directed caudad. The sternum is similar in shape to the tergum, but is larger. The tergum and sternum are widely separated on the sides of the segment by the very large pleura. Each of these plates is oval or rhomboidal, strongly convex on the outer surface, and bears distally, on the inner face, a long, densely chitinous, bent, blunt spine directed inward and forward. All species of the Tipulidæ have lobes of some sort born on the ends of the pleura; these are collectively termed the *apical appendages*.

The guard of the penis (fig. 8) is a large flat plate on the floor of the genital chamber. The anterior margin is deeply emarginate, its posterior margin graduated and produced medially into a short blunt process. A deep groove extends along the mid dorsal line of both the body of the plate and the posterior prolongation. The penis most probably resembles that of the following species and lies in the groove of the guard. It was not found in the specimens dissected.

Arising from the lateral walls of the genital chamber there is, on each side, a biramous appendage, shown in fig. 11. The upper arm is the longer and has its distal half bent upward. The lower arm projects downward and caudad, and then is curved upward. The recurved parts of the two lower arms lie in the notch on the anterior edge of the guard of the penis. These two bifid processes are here, as explained in the introduction, tentatively called the *second gonapophyses*. The guard of the penis is regarded as being formed of two rami converging and fusing beneath the penis, which constitute the *first gonapophyses*.

Antocha sp. inc. (Pl. VIII, figs. 3, 6, 7).

This species is very similar to the last, but the hypopygium differs externally in having the pleural lobes slenderer and less convex. The tergum also is widely truncate and concave posteriorly. The apical appendages are two in number on each side, and they are thicker than in *A. opalizens*.

The internal parts of the hypopygium differ more in the two species than do the outer parts. The guard of the penis consists of a small triangular plate, with the lateral edges turned up so as to make a short triangular trough in which lies the distal half of the penis. From the basal angles there diverge anteriorly two wide flat arms (fig. 6).

The penis (fig. 3) can be, in this species, very easily isolated. It is a short, thick, semi chitinous rod, expanded slightly at the middle and ending in a small enlargement. It arises from a biramous, expanded base between the arms of the guard.

The second gonapophyses have the same essential structure as in *A. opalizans*. Here, however, the lower arm of each is the larger, and is strongly bent upward beyond the middle (fig. 7). The upper arm is nearly straight and bears a small process distally on the upper margin.

Genus **DICRANOMYIA**.

In this genus the sternum of the hypopygium is rudimentary. The pleura are large and reach the anterior margin of the segment. The apical appendages are large expanded lobes.

Dicranomyia longipennis Schum. (Pl. VIII, figs. 2, 4).

The abdomen is slender, the hypopygium forms a small oval enlargement. The eighth segment is very narrow, the dorsal part being a mere transverse band, the sternal part is larger but simple.

The tergum of the hypopygium is a large trapezoidal plate with the wider base anterior. The pleura are large ovoid plates strongly convex outwardly, reaching the anterior margin of the segment and projecting posteriorly far beyond the tergum. The sternum is membranous and rudimentary (fig. 4).

There are two apical appendages on each side, one ventral, the other dorsal. The ventral one is a large pale oval lobe, as large as the pleurum itself. From its inner basal angle there projects inward and forward a slender arm that bears terminally two long bristle like spines projecting posteriorly. The dorsal appendage has the form of a long curved sickle-like hook (fig. 4).

The guard of the penis is an elongate structure strongly decurved at the tip (fig. 2, *p*, *g*). Basally it is prolonged into two slender divergent arms implanted in the membranous floor of the genital chamber. The penis is simply a curved rod-like tube, somewhat thickened toward the base, arising immediately before the base of the guard between its two roots.

The second or upper gonapophyses arise from the anterior wall of the genital chamber. They are simply two thin triangular plates set vertically over the guard. Each has the tip prolonged into a small up-curved hook (fig. 2, *gon. 2*).

Dicranomyia venusta Berg. (Pl. VIII, fig. 1).

This species is very similar to *D. longipennis*. The eighth segment, however, is much larger, its sternum is considerably prolonged beyond the tergum (fig. 1), giving an upward bend to the end of the abdomen.

The tergum of the hypopygium rises almost vertically from the eighth tergum. The pleura are large, each with a prominent lobe near the distal end of the lower margin. The sternum is rudimentary.

The guard of the penis and the penis are almost identical with those of the last species. The guard is apparently a closed tube surrounding the penis, at least, a careful examination revealed no groove or even a suture along the dorsal line. If a specimen be allowed to dry and then examined in liquid, the space around the penis within the guard will be seen filled with air.

The second gonapophyses are thin vertical plates projecting backward from the front wall of the genital chamber. The distal convex edge of each bears an up turned hook at the middle.

Genus **LIMNOBIA** Meigen.

The members of this genus resemble those of *Dicranomyia* in having the hypopygial sternum rudimentary. Both genera belong to Osten Sacken's first group of the Tipulidæ, the Limnobina.

Limnobia sciophila O. S. (Pl. IX, figs. 16, 19, 20).

The abdomen is slender. The hypopygium does not form an enlargement; it is somewhat upturned but is tapering.

The eighth segment is simple, composed of a normal tergum and sternum, the latter a little the larger.

The tergum of the hypopygium is a plain transverse plate, placed almost vertically, but constituting the true dorsal surface of the segment. The pleura are large plates entering the anterior margin of the segment, expanded back of the middle and then again contracted. Each bears distally a large hook like lobe, the apical appendage (figs. 16 and 19), which is greatly swollen at the base and directed inward and forward.

The sternum consists of a narrow bridge uniting the anterior ends of the parallel lower edges of the pleura. From the dorsal side of this bridge arises the penis and its guard. The guard (fig. 20, *p, g*) consists of a median plate grooved along the middle line above, ex-

panded laterally near the base, tapering toward each extremity, ending distally in two deflexed points. The penis is a narrow chitinous tube lying in the groove of the guard, and arising from two diverging roots in front of it.

The second gonapophyses (fig. 20, *gon. 2*) consist of two slender triangular plates projecting into the genal chamber above the guard of the penis, and arising from two long roots that run forward to the base of the guard. These really arise from a more dorsal level than the base of the guard, although not clearly so shown in fig. 20, which is a ventral view of the parts.

The forms that follow the genera so far described, in the structure of the hypopygium, have the pleural plates excluded from the lateral parts of the segment and attached as appendages on its posterior rim. The series thus derived from *Antocha* and the Limnobina are the genera of the Limnobina Anomala exclusive of *Antocha*, the Eriopterina, the Limnophilina, the Anisomerina and the Amalopina. The genera of the Ptychopterina (*Bittacomorpha* and *Ptychoptera*) constitute another group in which the pleura intervene between the tergum and sternum. From them are derived the genera of the Tipulina, with *Pachyrrhina* as a transitional genus, in which the pleura retreat from the anterior margin of the segment but become fused with the sternum.

Genera **RHAMPHIDIA** Meigen, and **DICRANOPTYCHA** O. S.

In both of these genera of the Limnobina Anomala the hypopygium consists of a circular ring-like body, composed of the tergum and sternum, and of two large lobes attached laterally to the posterior rim of this ring. These appendicular lobes are apparently the pleura, for in these genera, and in all the others related to them, they bear distally the apical appendages.

Genera **ERIOPTERA** Meigen, **TRIMICRA** O. S. and
SYMPLECTA Meigen.

These genera represent Osten Sacken's Section III, the Eriopterina. They resemble the last two in that the body of the hypopygium is ring like, and the pleura are appendicular.

Erioptera septentrionis O. S.

The body of the hypopygium consists of a simple ring in which there is not even a suture between the tergum and sternum. The

genital chamber is a wide open cup shaped invagination of the posterior face of the segment.

The tergal part of the hypopygium is prolonged posteriorly beyond the lateral parts as a quadrate lobe with the caudal margin emarginate. The pleural lobes are large, convex outwardly, slightly narrowed at the distal end and roundly truncate. Two apical appendages arise from the inner face of each pleurum near its distal end. The more dorsal one is short and spatulate, and has a strong sharp hook arising from its base. The inferior one is a long, slender, strongly chitinous, tapering, knife like blade. Both are directed inward and forward.

The guard of the penis is plate-like. The second gonapophyses are forked appendages arising above the guard from the sides of the genital chamber.

Trimiera anomala O. S. (Pl. VIII, fig. 9).

The hypopygium of this species is very similar to that of the last. The pleural plates, however, are larger and give a more expanded appearance to the end of the abdomen.

The tergal part of the hypopygium is somewhat produced posteriorly as a truncate plate (fig. 9). The sternal margin is entire and slightly convex. There are no sutures between the tergum and sternum. The pleura are very large oval lobes, strongly convex on all sides, and widely divergent (fig. 9). One large curved finger-like process, with a sharp and strongly chitinized tip, projects inward and forward from the apex.

The guard of the penis (fig. 9, *p*, *g*) is an elongate triangular process, grooved above, arising from the floor of the genital chamber and mostly projecting out of the latter posteriorly.

The second gonapophyses (fig. 9, *gon.* 2) are strong hooked processes arising from the walls of the genital chamber above the base of the guard.

Symplecta punctipennis Meigen (Pl. VIII, figs. 10, 12).

The abdomen is slender. The body of the hypopygium is narrower than the preceding segments, but the flaring pleural lobes stand out prominently at the end of the abdomen. The eighth segment is very short (fig. 12).

The body of the hypopygium is ring like, with no sutures between tergum and sternum. The sternal part is concave on the posterior

border. On the tergal aspect the chitinous parts are interrupted medially by a large triangular membranous area anteriorly, connecting with a crescentic membranous area posteriorly (fig. 12). The pleural lobes are large and strongly convex outwardly. Each is somewhat more than twice as long as the body of the hypopygium, and bears on the upper edge, near the distal end, a short, thick, expanded, non-articulated lobe directed inward and forward.

The guard of the penis is a flat plate, with the angles of the posterior truncated end expanded laterally. The second gonapophyses are large and densely chitinized processes (figs. 10 and 12, *gon. 2*) projecting from the sides of the genital chamber above the guard. The free part of each consists of two short thick arms, the inner longer, serrate distally, and blackly chitinous. The two pairs are connected medially by a short transverse process from each, the two uniting to the middle line. Each gonapophyses has a long rod-like apodeme extending forward into the abdominal cavity (fig. 10, *ap.*).

Genus **LIMNOPHILA** Macq.

In the structure of the hypopygium this genus differs in no essential manner from the genera of the Eriopterina. It may be taken as typical of Osten Sacken's fourth group, the Limnophilina.

Limnophila cubitalis O. S. (Pl. IX, fig. 14).

The hypopygium and genital chamber form a simple cup like structure open dorsally and posteriorly. The ventral part of the rim is somewhat produced posteriorly.

From the floor of the genital chamber there projects upward and posteriorly, at an angle of about 45 degrees, a short, thick, tubular structure having a slender, chitinous, brace-like plate running outward from it on each side. This is the penis and the first and second gonapophyses.

The penis itself, when divested of the ensheathing plates and membranes, is seen to be a slender cylindrical tube, arising from an enlarged base on the floor of the genital chamber, and extending posteriorly and upward so that the tip, which is enlarged and bent forward, projects out of the cavity (fig. 14, *p*). It is protected dorsally by two plates that arise near its base and converge and unite upon its tip. Ventrally the penis is protected by two similar plates arising below its base, converging upon the under surface of the tip, but uniting here for a longer distance than do the dorsal plates.

These four plates, arising thus two above and two below the base of the penis, and converging about its tip, apparently are the four gonapophyses.

Limnophila rufibasis O. S. (Pl. IX, figs. 17, 21, 22, 23, 25).

The hypopygium forms but a slight enlargement of the abdomen. The body of it is a narrow ring. The tergal part is deeply notched and the corners of the notch are produced into small blunt points (fig. 23). The pleura are very large lobes, convex on all sides, membranous on the inner surfaces. Each bears distally two apical appendages, one of which (figs. 22, 23) is directed posteriorly and the other inward and anteriorly.

The penis arises from a large biramous base on the floor of the genital chamber (fig. 17, *b*, *p*, fig. 21). Beyond the base it is received into the guard (*p*, *g*). This is a large, compressed, oval structure, with the distal end produced into a decurved prolongation. It is composed of two thin lateral shells continuous with each other below, and united above in a suture, forming thus a capsule entirely enclosing the penis. The latter forms a slender curved tube within the guard.

The second gonapophyses are two long, slender, tapering, decurved rods, arising from the anterior wall of the genital chamber and extending posteriorly a little beyond the guard (fig. 23, *gon. 2*, and fig. 25).

In this species there is a well developed anal tube or tenth segment (fig. 23, *a*, *t*) arising from the roof of the genital chamber and projecting out of it posteriorly.

Limnophila quadrata O. S. (Pl. IX, fig. 18; Pl. X, fig. 34).

The abdomen is slender and cylindrical, the hypopygium does not form an enlargement. The eighth segment is a simple narrow ring.

The body of the hypopygium consists of a perfectly simple ring, wider than the eighth segment, undivided by sutures, having only a wide notch in the posterior margin below. The pleural lobes are somewhat elongate, and each bears terminally two slender, tapering apical appendages directed inward and forward.

The guard of the penis is a long tube greatly swollen in its basal half; slender, cylindrical or tapering and curved upward in its distal half (figs. 18 and 34, *p*, *g*). The length and the curve of the distal half vary considerably in different specimens. In some the

terminal part is simply turned up, in others the distal half curves upward and then forward again. Under the microscope a tube can be seen fitting closely inside of the guard. By pressing on the cover glass it can be proved that this appearance is not merely an optical effect, for the outer tube clearly separates from the inner. By breaking the structure apart, however, the two tubes break with such even fractures that they cannot be easily demonstrated in this way. The inner tube is the penis.

Arising from the sides of the genital chamber, and apparently from the inner faces of the pleura, above the base of the guard, are the second gonapophyses. Each is a biramous process, the two arms forming a large angle with each other (fig. 34, *gon. 2*), and is supported by an arm-like apodeme (*ap.*) extending forward and upward.

Genus **EPIPHRAGMA** O. S.

This genus also belongs to the Limnophilina, and presents the same type of structure as *Limnophila*.

Epiphragma fascipennis Say (Pl. IX, figs. 13, 15).

The abdomen is somewhat long and slender. The hypopygium forms only a slight enlargement. The sternum of the eighth segment is much larger than the tergum, and extends posteriorly beneath the ninth segment.

The body of the hypopygium is undivided by sutures; the tergal margin is slightly convex and notched, the sternal margin is entire. The pleura are extraordinarily large triangular lobes, their bases are high and almost meet each other dorsally (fig. 13). Each lobe bears two apical appendages directed inward and forward. The outer and more ventral one is blunt and cylindrical, the other is more dorsal but is mostly concealed by the outer, and is hook-like.

The guard of the penis is a narrow, triangular structure, having the tip somewhat prolonged and curved upward. The penis itself is a short rod-like tube, arising just in front of the base of the guard from two long prong-like roots, resembling the tines of a fork. Between them the ejaculatory duct enters the penis.

The second gonapophyses are of rather curious shape (fig. 15). Each consists of a long, slender, tapering arm lying along the side of the genital chamber, and arising from the lower end of a vertical rod lying against the anterior wall of the genital chamber, and projecting a little out of it dorsally (fig. 13, *gon. 2*). Attached to the

anterior edge of the vertical rod, at about its middle, is a large triangular scapula like apodeme (fig. 15, *ap.*). Only the posterior narrow neck of this plate projects into the genital chamber. The whole structure can be regarded as a bifid rod arising from an apodeme, which is the common form of the second gonapophyses in the genera so far described.

A short, cylindrical anal tube is present.

Genus **ERIOCERA** Macq.

This genus closely resembles *Limnophila* in the structure of the hypopygium. It is here described because it represents the small group Anisomerina, Osten Sacken's Section V.

Eriocera eriophora Wils.

The body of the hypopygium is a simple ring, widest on the sides, very narrow below, constricted above by a posterior emargination. The pleura are large, almost cylindrical lobes, appendicularly attached to the rim of the hypopygium. Each bears distally two long, curved apical appendages directed forward and inward. The convex border of the anterior appendage fits into the concave border of the posterior, giving to the two a beak-like appearance.

Genus **AMALOPIS** Haliday.

This genus may be taken as representative of the group Amalopina. In it the pleura attain their best development as appendages of the rest of the hypopygium. That is, their appendicular condition is most pronounced, and the apical appendages proper are reduced to small processes and hooks.

Amalopis constans Doane (Pl. IX, figs. 24, 26, 31, 32).

The abdomen posteriorly is somewhat tapering. The hypopygium forms a small but abrupt globular enlargement (fig. 32). The tergum of the eighth segment is larger than the sternum.

The hypopygium has the tergum separated by sutures from the sternum. The former is a simple plate with the posterior border gently convex, and slightly notched medially (fig. 26). The sternal margin is medially produced into two small knobs (fig. 24). The pleural are large, thick and subcylindrical (fig. 32). Each is strongly chitinous and very convex on the outer surface, but presents a large irregular, median, non-chitinous area on the inner surface (fig. 31). The distal end is produced into a long median finger-like process,

and into an anterior and a posterior lobe that are shorter and comparatively thicker. Near the distal end of the inner surface each pleurum bears a small two-hooked process. This probably represents the two apical appendages.

Amalopsis inconstans O. S.

The parts of the hypopygium are in general very similar to those of the last species. The processes and hooks on the pleura, however, are distinctly different. The posterior or ventral distal angle of each pleurum is elevated into a large rounded lobe. The anterior or dorsal angle is produced into a lengthened spatulate process. Within the latter is a large bifid process projecting forward, upward and inward.

Amalopsis ampla Doane (Pl. IX, figs. 27, 28, 29, 30).

The abdomen is cylindrical, the hypopygium forms a conspicuous enlargement at the end. The eighth tergum is short, but the eighth sternum is very long, being much produced posteriorly. On this account the hypopygium is turned upward at an angle of about 45 degrees.

The body of the hypopygium has no sutures between the tergum and sternum. It is somewhat funnel shaped, the posterior rim being wider than the base. The tergal part is produced posteriorly into an oblong, semi chitinous plate ending in two points (fig. 29), and reaching far beyond the lateral and ventral parts of the segment (fig. 30). The sternal margin is widely emarginate (fig. 28). The pleura are large, flat, oblong lobes rising vertically, or inclined forward, from the rim of the genital chamber (figs. 30, 27). Each bears at the distal end six large, hook-like processes. In this species the pleura are decidedly appendicular being attached by narrow bases to the body of the hypopygium.

Genus **PHALACROCERA** Schiner.

This genus is described simply because it is representative of Osten Sacken's Section VII, the *Cylindrotomina*. The hypopygium is anomalous in some ways and its position in the series is not clear.

Phalacrocera tipulina O. S.

The hypopygium is somewhat box shaped. The tergum is a wide, almost square plate, with a median linear notch behind. The chit-

inous part of the sternum is deeply cleft in the median line posteriorly, but the notch is occupied by membrane. The pleura are fused with the lateral parts of the sternum, but each stands out as a prominent triangular lobe on the posterior rim of the hypopygium. Each carries, articulated to it, a long, slender, tapering process ending in a recurved hook.

The penis and its guard have a most unusual form. The two together appear to constitute one structure composed of a short, thick body bearing three terminal prongs projecting posteriorly and a short spike like process projecting dorsally. Above it are two elongate plates lying against the roof of the genital chamber.

Genera **BITTACOMORPHA** Westw., and **PTYCHOPTERA** Meig.

In these two genera we go back again to the primitive structure of the hypopygium found in *Antocha* and in the Limnobina Anomala, where the pleural plates occur in their normal position on the sides of the segment between the tergum and the sternum. Hence, we have two groups of genera possessing this primitive hypopygial structure. From the first we can derive the series of genera, beginning with *Rhamphidia* and ending with *Amalopsis*, in which the pleura are appendicular. From the second group, Section VIII of Osten Sacken, the Ptychopterina, we can derive the genera of the Tipulina, where the pleura again recede from the front of the segment but become fused with the sternum.

Bittacomorpha clavipes Fab. (Pl. X, figs. 35, 36, 37, 38, 39).

The appearance of the hypopygium in side view is shown in figure 35. The eighth segment is here removed and the intersegmental membrane (*m.*) between the eighth segment and the ninth is exposed.

The tergum is a large, wide, strongly convex plate, covering not only the dorsal surface of the hypopygium but also the dorsal half of each lateral surface. The posterior margin is concave above (fig. 37), convex on the sides. Just above each lower posterior angle there is movably articulated to the posterior margin a long slender appendage extending posteriorly and slightly curved inward (figs. 35 and 37, *a*). These appendages are simply special organs in the species, having no recurving homologous representatives elsewhere. Similar lobes occur also in scattered cases on the sternum, as for example, in *Ptychoptera lenis*. The notch on the posterior margin of the tergum is occupied by a narrow fold of membrane in which there is situated a small nodule of chitin.

The sternum has the form of an equilateral triangle with the anterior side convex and the lateral sides concave. It lies mostly upon the ventral side of the hypopygium. The posterior median angle is truncate and emarginate. From the two points thus produced there arises, from two corresponding roots, a large, darkly chitinized, hammer-shaped appendage (fig. 38, *b*).

The tergum and the sternum are separated entirely, on the sides of the segment, by the pleura (fig. 35). Each pleurum is an elongate triangular plate, having anteriorly an uncinat prolongation extending into the intersegmental membrane (*m.*) back of the eighth segment far in front of the tergum and sternum. A chitinous bar arises from the pleurum near its base (fig. 39, *c*), and extends inward, lying in the floor of the genital chamber. Its edges are provided with a number of small teeth. There is only one apical appendage on each side. This is an elongate arm widest at its base, tapering distally and curved inwards. It is born at the distal end of the pleurum.

The guard of the penis is a small elongate triangular structure, apparently enclosing the penis on all sides (fig. 36, *p. g.*). The penis projects from the tip as a small chitinous rod (*p.*). In front of the base of the guard are two pairs of small chitinous points arising from the floor of the genital chamber, which may represent the bifid second gonapophyses.

Ptychoptera lenis O. S. (Pl. X, figs. 40, 41, 42, 43, 45).

The hypopygium forms a small globular swelling at the end of the abdomen. The eighth segment is normal, the sternum is longer than the tergum (fig. 40).

The body of the hypopygium is formed of a large dorsal and dorso-lateral tergum, a ventral and ventro-lateral sternum, and two small pleural plates, one on each side between the tergum and the sternum. The tergum is deeply notched medially (fig. 41), so that the median part forms simply an anterior bridge connecting the two large lateral lobes. Each of the latter is strongly convex laterally, concave on the inner edge and produced here into a larger posterior and a smaller anterior lobe. The sternum is a simple plate, widest on each side where it forms the lower lateral surface of the segment (fig. 40). Each of these lateral parts carries on its posterior edge a large articulated lobe (fig. 40, *l.*, and fig. 44) extending upward and

posteriorly, the dorsal end being hidden between the apical appendages. Each pleurum is a small, elongate, triangular plate lying along the middle of the side of the segment. Its anterior end does not quite reach the anterior margin of the hypopygium. A narrow tapering bar runs downward from the anterior angle of the tergum and meets a similar bar running upward from the corresponding angle of the sternum. There is formed thus a narrow bridge uniting the tergum and the sternum in front of the pleurum. The posterior end of the pleurum projects as a small rounded lobe into the angle between the tergum and the sternum, and carries the apical appendage (fig. 40). There is only one apical appendage on each side. Each is a long, slender, inwardly curved, club shaped lobe projecting posteriorly and upward (fig. 40, *ap.* and fig. 45).

The guard of the penis consists of two elongate, blade-like plates set on edge side by side, arising from the floor of the genital chamber. Their lower margins are united by membrane, so that there is thus formed between the two plates a deep narrow groove. This lodges the penis. The latter is a simple, short, straight, rod-like tube, arising from two diverging roots from the lower part of the anterior wall of the genital chamber. The second gonapophyses arise from the anterior wall of the genital chamber. Each is a short blade like plate much resembling a half of the guard of the penis and like it set on edge. In this genus, therefore, the penis and the gonapophyses are much more nearly primitive than in *Antocha*. If the lower edges of the sides of the guard were not united, we should have the simple condition of the penis surrounded by a pair of processes above it and a similar pair below it.

Group **TIPULINA.**

The group Tipulina is Osten Sacken's Section IX of the Tipulidæ. It includes, besides several other genera, the following genera which are described in this paper: *Pachyrrhina*, *Tipula* and *Ctenophora*. It undoubtedly belongs at the top of the family. In certain characters of the hypopygium the members are highly specialized and differ uniformly from all the other genera.

The characteristic features of the group, in the structure of the hypopygium, are: (1) the fusion of the pleura with the sternum; (2) the shifting of the base of the penis from the floor to the roof of the genital chamber, and the elongation of the penis in a large curve

forward; and (3) the thickening of the base of the penis to form a *central vesicle*. Less distinctive characters are the disappearance of the second gonapophyses, and the presence in most of the species of three apical appendages on each side.

The fusion of the pleura with the sternum is perfect in *Otenophora* and in many of the members of *Tipula*. In *Pachyrrhina* the condition is more primitive. In one species (*P. polymera*, Pl. XI, fig. 60) the suture between the pleurum and the sternum on each side extends to the anterior margin of the segment, but near the anterior end it is simply a groove. All the other species of *Pachyrrhina* examined have this suture ending some distance back of the anterior margin of the segment. The suture may have a simple termination as in *P. lugens* (Pl. XI, fig. 51), or, as in more general, the anterior end may be abruptly bent upward, as in *P. incurva*, *P. ferruginea* and *P. pedunculata* (Pl. XI, figs. 53, 56, 59). In many species of *Tipula* this vertical arm of the suture is extended upward to the tergal suture, thus cutting off a plate, generally having a triangular shape, set into the posterior margin of the segment, between the tergum and the sternum and carrying the apical appendages. In these forms, then, the condition of the pleurum is intermediate between that of *Antocha*, *Dicranomyia*, *Bittacomorpha*, etc., where the pleurum has the normal position between the tergum and sternum, and that of *Erioptera*, *Limnophila*, *Amalopsis*, etc., where the pleurum is an exserted lobe upon the posterior rim of the hypopygium. The arrangement of the genera in such a sequence, however, is precluded by the structure of the penis and other organs.

In the lower genera of the Tipulidæ the penis has the form of a short straight rod, generally arising from two diverging root like arms (e. g. see *Antocha*, fig. 3; *Limnophila*, fig. 21; *Ptychoptera*, fig. 42). In the Tipulina the penis has a very different appearance. It arises from a large, swollen, darkly chitinous vesicle, the *central vesicle* situated on the roof of the genital chamber (see section of *Tipula angustipennis*, Pl. XVII, fig. 149, c. v.). From the anterior end of this vesicle the penis curves forward and downward close to the anterior wall of the genital chamber, and then goes posteriorly on its floor (fig. 149, p.). Often it goes far forward in the abdomen within a special prolongation of the genital chamber, before turning posteriorly. It may reach even into the first abdominal segment.

The central vesicle usually has the form shown in figures 144 and

146 on Plate XVII. It consists of a very convex, often hemispherical, strongly chitinized body projecting into the genital chamber from the dorsal wall of the latter. Posteriorly there project from its base two arms (*a*) that diverge posteriorly, upward and outward in the roof of the genital chamber. From the anterior angles of the base two wider and shorter plates project anteriorly and outward (*b*). From the dorsal surface there project dorsally two large apodemes (*c*) into the space between the genital chamber and the tergum of the hypopygium. It is evident that the posterior arms of the central vesicle may be homologous with the anteriorly diverging roots of the penis in the lower genera. If the base of the penis in any of the latter forms were carried up the anterior wall of the genital chamber and then forward upon the dorsal wall, the arms originally projecting anteriorly would come to project posteriorly.

Between the posterior arms of the central vesicle, in the dorsal wall of the genital chamber, is a chitinous bar generally composed of two arms diverging posteriorly outward to the side walls of the genital chamber. This bar, on account of its usual shape and position, will be called the *V-shaped brace* (fig. 148). It sometimes does not have this typical form, however, and may be absent.

In some species of *Pachyrrhina* there are present rod-like appendages arising from the base of the guard of the penis that may be second gonapophyses. In *Tipula* such appendages are generally absent. When they are present they usually project posteriorly below the guard, and arise either from the sides, or the lower part, of its base. If these appendages are the homologues of the second gonapophyses in the lower genera, they have become greatly displaced.

Throughout the entire group there is a strong tendency toward the formation of three apical appendages. One of these is always situated dorsal to (which may mean either above or in front of) and on the outer side of the others. This is the one called by other authors the *upper appendage*. The second appendage is often concealed within the first and has been called the *middle appendage*. These two are almost invariably present and evidently are homologous with the apical appendages of the lower genera. The third is developed as a small lobe on the outer side of the base of the second. It is rudimentary in *Pachyrrhina*, *Ctenophora* and in many species of *Tipula*. In a large number of the species of *Tipula*, however, it is

well developed and often entirely separated from the second. It has been called the *lower appendage*. In the following descriptions the three will be referred to as the first, second and third appendages respectively, or as the upper, middle and lower, where there are three present; and in the figures they are lettered A, B and C respectively. The varying shapes of the three appendages will be shown in the special descriptions. The second has an almost constant character, however, that may be mentioned here. This is a thickening on the outer side of the anterior edge that appears as a partially detached and reflected plate, and nearly always ends in a free point above lying against the outer surface of the main body of the appendage. Typical examples are figures 83, B; 89, B; 121, B; and 159, B.

The tenth segment is a well developed tube, especially in *Tipula*, with the anus at the end. It arises from the dorsal part of the anterior wall of the genital chamber. It is generally contained within the latter, but in some cases projects prominently out of it (fig. 149, *a. t.*). In shape it is most often trihedral, one ridge being dorsal, and is always membranous, though in a few cases chitinous plates or bars appear in its walls.

Genus **PACHYRRHINA** Macq.

This genus is placed first in the series, because in the external structure of the hypopygium it most nearly resembles *Bittacomorpha* and *Ptychoptera*.

Pachyrrhina polymera Loew (Pl. XI, figs. 50, 60).

The hypopygium forms only a slight enlargement at the end of the abdomen. The eighth tergum is normal, the eighth sternum enlarged and prolonged beneath the ninth.

The tergum of the hypopygium is a simple convex plate, considerably wider than long, the posterior margin deeply cleft mesially, produced into a short outward curved point on each side. The sternum is a large plate with a double rounded posterior border, being deeply notched mesially. Continuous forward from the apex of the notch is a narrow, median, membranous space reaching almost to the anterior margin of the sclerite. At the anterior end of this membranous area there is movably attached a short cylindrical appendage projecting downward and posteriorly, and bifid at the tip. Each pleural plate extends the entire length of the hypopygium (fig. 60), but anteriorly it is fused below with the sternum.

There are two apical lobes on each side born by the distal end of the pleurum. The first or upper (fig. 50, A) is large and conspicuous, wide at the base, convex externally, tapering distally, and curving posteriorly, ventrally and inward (fig. 60). The second (fig. 50, B) is situated ventrad of the other and also mesad of it so that it is almost hidden by the upper in a lateral view (fig. 60). This appendage is shorter and thicker than the other. On the outer side of its base is a small lobe that bears two slender hook like processes (fig. 50, C).

The guard of the penis projects posteriorly and upward from the floor of the genital chamber. It is a simple elongate process deeply cleft lengthwise above. From its base there arises a pair of long curved hook like processes projecting upward at its sides.

The central vesicle is imbedded in a dense mass of muscle and connective tissue on the roof of the genital chamber. The penis is very slender, in its terminal part so slender as to be almost thread-like.

Pachyrrhina lugens Loew (Pl. XI, figs. 51, 54).

The abdomen is club shaped, being evenly widened toward the posterior end. The eighth sternum is enlarged and prolonged beneath the hypopygium.

The tergum of the hypopygium is convex dorsally, notched mesially on the posterior margin, produced into a small point on each side of the notch. The sternum is very large; mesially it is deeply cleft by a linear notch from the posterior margin. The pleurum is well developed and is separated along its entire length from the tergum. The suture separating it from the sternum is distinct along the posterior two thirds of the segment, but vanishes in front of this (fig. 51).

The apical lobes (fig 54) are two in number on each side. The upper (A) is elongate, fusiform and flattened. They project from the hypopygium like cerci from the tenth segment of other insects. The lower appendage (B) is wide, flattened, scale-like, hooked anteriorly, and is curved forward so as to lie beneath the ninth tergum. Two small lobes arise from the outer side of its base (C).

The guard of the penis is a simple, grooved, decurved process. From each side of its base there arises a small, flat, lobe with a terminal hook. These and also the similarly situated processes in *P. polymera* are probably the second gonapophyses.

Pachyrrhina erythrophagus.

The general shape of the abdomen and the hypopygium is very similar to that of the last species. The suture separating the pleurum from the sternum, however, is shorter and is curved upward at its anterior end for a very short distance. The upper apical appendage is wider than in the last species, the inner is more tapering.

Pachyrrhina incurva Loew (Pl. XI, figs. 52, 53).

The abdomen is club shaped as in the last two forms, the hypopygium not forming an abrupt enlargement.

On the sides of the hypopygium a strongly bent suture (fig. 53) partially separates the pleurum from the sternum. There are two apical appendages, the outer and upper one is elongate and slender, the lower is large, flat, with several irregular processes projecting upward.

In this species the penis is greatly prolonged, reaching forward into the first segment of the abdomen. The central vesicle lies very close to the floor of the genital chamber. From it the penis first curves upward (fig. 52) to the dorsal part of the abdomen, it then turns anteriorly and extends into the first abdominal segment. Here it makes a small loop ventrally, doubling upon itself and then again goes posteriorly close along the forward running arm. Posteriorly it descends past the anterior part of the central vesicle and finally turns posteriorly close upon the floor of the genital chamber. The posterior end is held in the guard of the penis. A delicate sheath, consisting of a tubular evagination from the genital chamber, contains the two arms of the loop of the penis.

The guard of the penis is a simple tapering process (fig. 52, *p. g.*) grooved above, arising from the floor of the genital chamber above the posterior edge of the sternum. Two free tapering arm-like processes extend downward and posteriorly from its base.

Pachyrrhina pedunculata Loew (Pl. XI, figs. 57, 58, 59).

Externally the abdomen is very simple, being evenly enlarged toward the posterior end.

The tergum of the abdomen is notched mesially in the middle line and on each side of this the margin is produced into a small point. The sternum is undivided below, but the median part is membranous. The pleurum is separated posteriorly from the sternum by a suture angularly bent upward at the anterior end (fig. 59).

There are two apical appendages on each side (fig. 58). The upper is a simple flat lobe tapering distally (A). The lower (B) lobe is wide and flat ending above in a narrow neck like process. Covering the outer anterior edge of the main lobe is a partially detached plate ending above in a free point. On the posterior distal angle is a high thin crest-like lobe, and on the outer side of the base a small elongate lobe (C).

The penis extends forward to the anterior part of the sixth segment, making an ordinary wide bend. The central vesicle (fig. 57, *c. v.*) faces anteriorly, *i. e.*, the surface usually directed downward is turned forward. The penis, hence, first goes dorsally and posteriorly making a wide loop by curving downward to the ventral part of the abdomen in the sixth segment, and then going posteriorly to the guard of the penis on the floor of the genital chamber. The latter (fig. 57, *p. g.*) consists of a straight tapering rod grooved above. A thick tapering process projects posteriorly from its base; from each side of the base there arises a slender sickle shaped process.

***Pachyrrhina ferruginea* Fab. (Pl. XI, figs. 55, 56).**

The hypopygium is very simple in its structure. The tergum is deeply notched in the median line on the posterior border. The sternum is also deeply notched mesially. The pleura are separated from the sternum on each side by a suture running forward three-fourths the length of the hypopygium and then ending in an upward bend.

Of the two apical appendages the upper is thin, wide basally and tapering distally, and is curved inward. The lower one is wider and shorter and ends in a point directed upward and forward. On its outer anterior edge is an elevated ridge ending above in a free point.

The penis extends forward to the anterior end of the fourth segment. The guard of the penis is simply a trough-shaped structure projecting backward from its origin on the floor of the genital chamber just in front of the notch of the sternum. The base of the guard is expanded laterally, and from each expansion there projects posteriorly a long bifid appendage (fig. 55.) The lower arm on each side is the larger. It is tapering, convex outwardly along the basal half, inwardly along the distal half, and terminates in a small knob. The dorsal arm is shorter, slenderer and more tapering than the lower. From the common base of each pair a long arm-like pro-

cess extends forward buried in the muscle and connective tissue of the floor of the genital chamber.

Genus **TIPULA** Linn.

According to the structure of the hypopygium, Westhoff, whose paper on the hypopygium of *Tipula* was discussed in the introduction to this paper, divides this genus into seven groups. These groups, however, are established on combinations of so many characters, and on characters whose morphological value is small on account of their variability, that they can scarcely be regarded as natural divisions or as having any phylogenetic significance.

The most fundamental modification that takes place in the hypopygium of the entire family is the variation in the position of the pleura. But Westhoff, in his study of *Tipula* alone, almost entirely overlooked these plates. However, if we arrange the species of *Tipula* according to the structure of the pleural plates, we shall have three groups that very logically follow in succession after the genus *Pachyrrhina*. These three groups will be characterized as follows:—I, the pleural region, on the side of the hypopygium, is separated from the sternum by a latero-ventral suture ending in a short outward or upward curve near the middle of the segment; II, the pleurum is entirely separated from the lateral part of the sternum, and consists of a small generally triangular plate set into the posterior lateral margin of the segment; III, the pleurum is entirely fused with the lateral part of the sternum. For convenience we will call the suture below the pleural region in Group I the *pleural suture*. In Group II the plates called pleural plates or pleura can evidently not be equivalents of the entire pleurum in *Pachyrrhina* and in the genera below it.

GROUP I.

Pleural sutures present.

The presence of pleural sutures, almost identical with those of *Pachyrrhina*, very clearly places this group at the bottom of the *Tipula* series. The transition from *Pachyrrhina* is perfect. The following eight species examined belong here.

Tipula fumosa Doane (Pl. XII, figs. 64, 65).

The eighth segment is shorter than in the last species. Its tergum is mostly concealed beneath the seventh (fig. 64), although the sternum is produced beneath the hypopygium.

The hypopygium is cup shaped, the rim of the genital chamber faces posteriorly and upward. The tergum bears a small, median, quadrate lobe on the posterior margin with the angles produced outward as two small horn-like processes. The sternum is continuous across the median line. On each ventro lateral aspect a suture runs forward from the posterior margin half way to the anterior. This is evidently the same suture that in *Pachyrrhina* marks the ventral margin of the pleurum, and is the one we will call in *Tipula* the *pleural suture*. The plate partially separated off above it always carries the apical appendages.

There are two apical appendages on each side. The first (figs. 64 and 65, A) is long, slender and curved. The second (B) is large, wide and flat. The distal half is curved forward. The basal half is quadrate and bears a tapering lobe on each distal angle.

The central vesicle and penis are of ordinary form. The latter curves through the eighth segment. The guard is a simple stylet-like structure deeply grooved above. Two small strap like processes project downward from its base at the posterior edge of the ninth sternum.

Tipula brevicollis (Pl. XII, fig. 69).

The pleural suture is present and bends slightly upward at its anterior end. The sternum is widely continuous across the median line, but is deeply emarginate posteriorly.

Tipula tricolor Fab. (Pl. XV, figs. 119, 121).

The eighth segment is normal and does not project specially beneath the hypopygium.

The hypopygium itself has a rather simple appearance and forms scarcely an enlargement of the abdomen (fig. 119). The tergum is small, and its posterior margin is graduated. The lateral parts of the sternum are attingent below, but are separated by a membranous suture. The only connection is a semi circular chitinous bar continuous from the anterior margin of one side to that of the other. A rather long longitudinal pleural suture on each side marks the lower edge of the pleural region, but otherwise the pleurum is not separated from the lateral part of the sternum. The part of the sternum below this suture forms a partially free lobe.

The apical appendages are very large and of regular outline forming an even outline posteriorly (fig. 119). The first appendage (fig. 121, A) is a very large, flattened, irregularly quadrate plate almost

entirely covering externally the other two. The second and third are united by their bases. The former (B) is triangular, its anterior angle produced into a rounded prolongation, the proximal part of its anterior border reflected as a free lobe on the outer side. The third appendage (C) covers the outer posterior part of the second. It consists of three partially separated lobes, one of which sends a long curved arm forward.

The central vesicle is of ordinary form. The V-shaped bar between its position arms is very large and apparently serves as a brace to keep the walls of the genital chamber apart. The guard of the penis is a simple stylet-like affair with a groove along the upper side.

Tipula cognata Doane (Pl. XVIII, figs. 154, 155, 157).

The eighth sternum is not specially modified, being neither armed nor produced beneath the ninth.

The tergum of the hypopygium is separated from the sternum by only an indistinct groove. The posterior margin of the tergum is produced into two slender, finger-like processes projecting caudally. The plates of the sternum are separated by a wide membranous area extending the entire length of the ventral aspect back of a narrow anterior connecting bar of chitin (fig. 155). The posterior edge of the sternum is deeply and widely emarginate. The median membrane expands posteriorly so as to form most of the posterior margin, and its free edge presents a chitinous thickening. From near each outer angle of the emargination a suture runs forward but ends back of the middle of the segment. The anterior end is very slightly curved outward. The two are the pleural sutures (figs. 154 and 155, *p. s.*).

There are only two apical appendages on each side (fig. 157). The first (A) is a simple, wide, somewhat fleshy plate, bluntly pointed distally. The other (B) is large and has the curious shape shown in figure 157. It consists of an upper part having the form of a flat, blunt hook with the tip curved forward, and of a similar but larger lower part extending downward and curving forward.

The central vesicle and penis have ordinary forms. The latter makes but a small curve forward. The guard of the penis is simple and stylet like.

Tipula caloptera Loew (Pl. XVI, figs. 128, 129, 130, 131).

The abdomen is widest through the seventh and eighth segments

(fig. 128). The hypopygium is relatively small, and projects upward and posteriorly from the eighth segment. The sternum of the latter is not specially produced beneath it.

The tergum and sternum of the hypopygium are not separate, and the pleural plates are not distinct from the sternum. Pleural sutures are present. The tergal aspect (fig. 130) is quadrate, roundly concave anteriorly, produced into three processes posteriorly, one of which is wide and median, the other two hook-like and situated nearer the lateral margin. The sternal parts (fig. 129) have essentially the same structure as in *Tipula bella*. The anterior margin is strongly convex. Separated from it by a narrow chitinous band is a large membranous area, and back of this is the posterior margin forming a deep re entrant angle. The pleural sutures (fig. 129, *p. s.*) running forward and then turning outward a short distance, set off two prominent mesal lobes of the sternum having free rounded apices. The apical appendages are three in number. The first (fig. 128, A) is triangular and attached by one of the angles. The other two consist of irregular plates mostly fused with one another.

The central vesicle is of ordinary shape. The posterior arms are somewhat long, and the apodemes relatively small. The ∇ shaped bar between the posterior arms of the vesicle is extremely large; it reaches on each side to the lateral walls of the genital chamber and embraces the base of the anal tube between its arms.

The guard of the penis arises from the floor of the genital chamber, above the anterior end of the sternal notch. It has the ordinary slender, tapering form, with a longitudinal groove above (fig. 131, *p. g.*). Basally it is triangularly enlarged. From this enlargement two short horn like roots project anteriorly (*a*). From the sides two large, free, elongate, flat, twisted arms proceed posteriorly (*b*). Each is widest near middle, curved inward distally, and ends in a small, blunt, hook-like point. The tips are visible below, from the outside of the hypopygium, projecting beyond the ends of the ventral sternal lobes (fig. 129, *b*).

Tipula tephrocephala Loew (Pl. XV, figs. 118, 120, 122).

The eighth segment is not specially modified. The tergum is relatively large and the sternum is no larger than the seventh (fig. 118).

The tergum of the hypopygium (fig. 120) has a simple quadrate form with two slender, divergent arms projecting posteriorly from the posterior margin. The lateral sternal plates are separated below

by a high, crest-like fold of membrane (fig. 118, *a*), except anteriorly, where they are united by a transverse, arched bar of chitin. A horizontal pleural suture running a short distance forward on the side of the hypopygium (fig. 119, *p. s.*) is present, the part above it carrying the apical appendages.

Of the three apical appendages (fig. 122) on each side, the first (A) is the largest. It is flattened and distally is curved posteriorly, and the two form a pair of conspicuous lobes at the apex of the hypopygium (fig. 118). The second (fig. 122, B) has the form of a flat hook with a very wide base and the point turned forward. The third lobe (C) arises from the outer side of the base of the second and overlaps this lobe externally. It has the complicated form shown in the figure.

The penis curves forward to the anterior part of the seventh abdominal segment. The guard is a simple structure composed of two thin, closely appressed blades, set on edge and united by their ventral edges.

Tipula bisetosa Doane (Pl. XIV, figs. 104, 106, 107).

The eighth sternum projects beneath the hypopygium. The posterior margin is notched. The lateral angles of the emargination are provided each with a long slender hook, from the apex of the notch there arises a wide brush of hairs.

The tergum of the hypopygium is distinct from the lateral parts of the sternum, and is simply emarginate posteriorly. The lateral parts of the sternum are separated by a rather wide membranous area below. This membrane ends posteriorly in a large fold (fig. 106, *a*). The pleura are not separated from the sternal plates. The pleural region on each side is limited below by a groove running forward a short distance from the posterior rim of the segment (fig. 106), and each has its margin produced into a small tapering process.

There are three apical appendages (fig. 104). The second (B) and third (C) are united basally. The first (A) arises from a slender peduncle lateral of the base of the other two. The first is wide, flat and spatulate. The second is elongate dorso-ventrally, and arises from a short thick stalk at right angles to the rest of it. The third is a triangle with the apex distal.

The guard of the penis (fig. 107, *p. g.*) is a short, fusiform structure composed of two blade-like, appressed plates set on edge and having their ventral edges united by membrane. From the sides of

the base two long, slender, slightly curved, tapering arms (*a*) project backward below the guard. Below these is a thicker, median, tapering arm bent downward at its middle, and then forward in a sharp hook (*b*). The central vesicle, penis, and anal tube are of ordinary structure.

Tipula bella Loew (Pl. XVI, figs. 123, 124, 125, 126, 127).

The hypopygium has the simple form shown in figure 123. There is no suture between tergum and sternum and there are no pleural plates separate from the sternum. Pleural sutures, however, are present as shown in figure 124. The tergal part is produced caudally beyond the apical rim of the lateral and ventral parts as a densely chitinous, triangular plate terminating in a decurved hook-like tooth.

Figure 124 shows a ventral view of the hypopygium with the apical appendages removed. The sternal margin is thus seen to be deeply notched by a deep emargination, which is linearly prolonged anteriorly past the middle of the segment. Here the notch ends against a large, pentagonal, membranous area which occupies nearly all of the ventral surface of the segment in front of the notch, leaving only a narrow arched bar of chitin forming the anterior sternal margin. This is a very general structure of the sternum throughout the genus. At about the middle of each lateral margin of the wide part of the sternal notch, a wide, membranous suture runs inward and then forward about two-thirds the distance to the anterior membranous area. Here it abruptly curves outward a short distance and ends. The two are the pleural sutures (fig. 124, *p. s.*). The tip of the sternal lobe formed on each side between the suture and the median notch rapidly tapers and turns mesially as a free point.

The apical appendages form one large irregularly lobed structure on each side. Figure 123 shows them in their natural position attached to the hypopygium. Figure 127 shows them somewhat flattened out in a lateral view. The first (A) is a large bi-lobed triangular, fleshy plate attached by an angle to the base of the others. The second and third (B and C) form together a tri lobed mass lying within and posterior to the first.

The central vesicle has its ordinary ventral surface directed anteriorly. The posterior arms, hence, extend downward and the apodemes posteriorly. The penis starts forward from the vesicle, but it

almost immediately makes a sharp bend dorsally and anteriorly (fig. 125).

The guard of the penis (fig. 126, *p. g.*) arises from the floor of the genital chamber over the ventral membranous area. It is a long, slender, tapering, stylet-like structure, grooved lengthwise above, swollen toward the base, arising by a contracted neck from a chitinous support on the floor of the genital chamber. From this support there projects posteriorly beneath the guard two weakly chitinous clavate appendages.

The anal tube has two delicate, band-like arms of chitin extending down upon its upper surface from the free edges of the tergum.

GROUP II.

Pleural plates present.

This group includes the majority of the species of *Tipula*. It is conceivable that the pleural plates have been formed by the secondary growth of the upturned anterior ends of the pleural sutures of Group I, in a dorsal direction, till they cut off back of them on each side the posterior end of the original pleurum. These plates always carry the apical appendages. If they have been formed in the manner just suggested, then Group II logically follows Group I.

Tipula angustipennis Loew (Pl. XVII, figs. 139 to 149).

The posterior part of the abdomen forms a club-shaped enlargement (fig. 139), and the hypopygium is directed upward and posteriorly.

The tergum of the hypopygium (figs. 141 and 142, IX, *t.*) is a wide plate having the anterior margin straight and the posterior deeply notched. The margins of the notch are formed by two partially detached, elongate lobes. The sternum consists of two large plates (IX, *s.*) covering most of the sides of the segment, but separated below by a rather wide membranous space (figs. 142, 147). Anteriorly the two are united in front of the membrane by a very narrow bar of chitin (fig. 147). The posterior margin of the membrane is deeply notched. From the bottom of the notch there projects posteriorly a slender, weak, tapering appendage (fig. 147 *a*). To each corner of it there is attached a small chitinous lobe (fig. 147, *b*). The pleura are well developed and are entirely separated from the lateral parts of the sternum (figs. 141, 142, 147, *pl.*).

Each is a large plate, somewhat irregularly triangular in shape, with a large posterior prolongation.

There are three apical appendages on each side, but the second and third are so united basally that they form one large bilobed structure. The first (fig. 142, A and fig. 143) is comparatively very small and is a simple, fleshy, cylindrical appendage. The second (figs. 140, 141, 142, B) is a large plate having in side view the form shown in figure 140. It is extended in transverse and perpendicular planes from the inner face of the pleurum, and the two form a double door like covering over the genital chamber. The third or lower most appendage appears like a large ventral lobe of the second (fig. 140). In side view it appears somewhat hood like being curled outward from above and then downward.

The central vesicle has the typical hemispherical form (figs. 144 and 146). The penis does not extend forward beyond the middle of the eighth segment (fig. 149).

The guard of the penis is a simple, thick structure (fig. 145), grooved above, widened basally and subterminally, ending in a short, thick, tapering prolongation.

Tipula trivitta Doane (Pl. XVIII, figs. 150, 151, 152, 153).

The general appearance of the apical end of the abdomen and of the hypopygium is similar to that of *Tipula angustipennis*. The posterior margin of both the tergum and sternum is notched. From the apex of the notch of the latter there extends forward a narrow membranous area. The pleura are distinct from the sternum, and each is roughly triangular in shape.

There are only two distinct apical appendages on each side (fig. 153). The first (A) has the common elongate, clavate form, and is articulated to the base of the second. The second (B) is a large, flattened, somewhat elongate plate, with the distal end tapering and turned forward, and the anterior margin reflexed outwardly as an elongate lobe, with a free distal end and posterior edge. From the posterior part of the base of the second there projects caudally a small triangular lobe (C), this may be the third appendage.

The central vesicle is flat; seen in side view (fig. 150, c. v.) it is scarcely convex below. The posterior arms are rather long and slender, and expand distally. From each lateral anterior angle a semi circular flap-like plate extends outward. Between the posterior arms is a bar of chitin that corresponds with the ordinary V-

shaped brace, but in this species it is bent into five sides of a hexagon (fig. 152). The open side is posterior. All of the sides are angulated in a dorso-ventral direction, so that the figure is not very regular in side view (fig. 150, *br.*). The penis is short and thick. It extends in a curve ventrally and posteriorly from the central vesicle (fig. 150, *p.*). Subterminally it is thickened and soft. It ends in a tapering point. The guard of the penis (fig. 151) consists of two high vertical plates set close together and united by membrane along their lower edges. Each is partially divided lengthwise into an upper and a lower half. The former projects posteriorly with a free blunt point (fig. 151), while the latter has a decurved terminal part ending in a small hook.

The tenth segment consists of a large, conspicuous, trihedral, anal tube projecting posteriorly between the apical appendages.

Tipula incisa Doane (Pl. XVI, fig. 136).

The eighth sternum is large and is produced beneath the hypopygium. Its posterior border is provided with a wide brush of hairs.

The hypopygium has the typical form, consisting of tergum, pleura and sternal plates, separated below by membrane, except anteriorly, where they are united by a chitinous bar.

The apical appendages (fig. 136) are three in number. The first (A) is a slender, delicate, sinuous rod. The second (B) is large, quadrate, and born on a thick peduncle. The third (C) is attached basally to the second. It is a wide plate of about uniform width.

Tipula truncate Meigen (Pl. XVI, figs. 132, 134).

The eighth sternum is somewhat enlarged and prolonged beneath the hypopygium. Its posterior margin bears a wide median brush of hairs covering the membranous area of the ninth sternum.

The hypopygium is somewhat elongate (fig. 132). The tergum is notched mesially, produced into a small point on each side. The sternum has the typical form, being composed of two lateral plates, separated by a membranous area below, except in front, where they are connected by a narrow chitinous bar. The posterior margin is notched. At each side of the notch is attached a small transverse lobe. The pleura are small, but are entirely separate from the sternum (fig. 132).

The apical appendages (fig. 134) are three in number. The first

is a slender club-shaped lobe (A). The second (B) has the typical form of a wide plate ending distally in a point turned forward, and having all but the terminal part of the anterior margin reflected externally upon itself as a narrow lobe with free edges. The third (C) is smaller, triangular, and arises from the outer side of the base of the second.

Tipula acuta Doane (Pl. XV, figs. 112, 113, 115, 116, 117).

The eighth sternum is enlarged and projects prominently beneath the hypopygium. Its posterior margin is concave and bears mesially two wide, crossed brushes of hairs (fig. 113). On each side there is articulated to it a wide appendicular lobe ending in three large blunt processes.

The hypopygium is of ordinary form, and consists of a distinct tergum, pleura and sternal plates. The tergum (fig. 117) is a wide plate with both anterior and posterior margins concave. On the posterior margin are two median triangular points. From the posterior angles of the sternum there project downward two slender arm like appendages (fig. 115).

The three apical appendages are simple. The first is flattened and clavate, the second largest and triangular, the third is small and attached to the base of the second.

The guard of the penis (fig. 116) is flattened and somewhat de-curved. Just beyond the base it contracts to a narrow stalk, beyond which it rapidly expands into a wide triangular plate, having the distal edge produced into a median and two lateral triangular lobes. A deep groove traverses the entire length above.

Tipula æqualis Doane (Pl. XIII, figs. 78, 79).

The eighth sternum is rather large and is deeply emarginate on its posterior border. From the apex of the notch there diverge downward and posteriorly two long slender brushes of hairs. From each lateral angle of the notch there arises a short conical lobe attached by its apex (fig. 78, *a*). Its distal flat end is triangular and concave, and the outer angle is produced into a large, strong, inwardly curved hook. In this character this species closely resembles *T. inermis*.

The tergum of the hypopygium is almost divided by a deep median notch. The sternum has the ordinary form, being deeply cleft mesially, with the two lateral plates united by a narrow bridge of

chitin anteriorly. Two large lobes (fig. 78, *b*) arise from the membranous areas ventrad of the pleural plates and hang downward. These are not apical appendages, for they do not arise from the pleura. The pleura are well developed as distinct plates set into the posterior upper angles of the sternum (fig. 78).

There are only two apical appendages on each side. The first is a simple clavate lobe rising vertically from the rim of the genital chamber (fig. 79, A). The second (B) is wide, flat, densely chitinous distally, with the tapering end directed anteriorly. Covering the basal three-fourths of the anterior edge is the characteristic flat elevation with free edges.

The guard of the penis is a narrow shaft that expands distally into a wide, flat, flaring, triangular plate. The latter ends in one median and two lateral points, each bearing a decurved terminal hook.

Tipula cineracea Coq. (Pl. XIII, figs. 80, 81, 82, 83).

The eighth segment is not specially enlarged. The seventh, eighth and ninth segments form a large knob-shaped swelling at the end of the abdomen. The hypopygium is directed posteriorly and upward at an angle of about 45° with the axis of the abdomen.

The tergum of the hypopygium is a simple transverse plate, emarginate posteriorly, separated on each side by a distinct suture from the sternum. The lateral sternal plates are separated below by a narrow linear membranous area. Their anterior angles are connected by a narrow bridge of chitin with a slender, median, tapering tongue of chitin running caudally in the membranous area back of it. Each pleural lobe is large, rhomboidal and set deeply into a notch on the side of the sternum.

There are three apical lobes on each side, but only the first two are well developed (fig. 83). The first (A) has the ordinary clavate form. The second (B) is larger and plate-like. It expands somewhat beyond the middle, and distally ends in a blunt point turned forward. Most of its anterior edge is covered by a narrow lobe like elevation. The third appendage (C) is a very small, simple, clavate lobe arising from the outer side of the base of the second.

The central vesicle is rather flat. The penis is also flat and strap like. It is short and bends almost immediately downward from the central vesicle. The guard of the penis consists of two longitudinal

plates set on edge, with the posterior end of each turned downward like a pistol grip (fig. 82, lateral view). A transverse V-shaped plate, with the apex greatly prolonged and trough-like, connects the two lateral plates and forms a wide groove lodging the penis (fig. 81, dorsal view).

Tipula retusa Doane (Pl. XIII, figs. 84, 85, 86, 87, 88).

The eighth sternum is extraordinarily large and very convex below. Its posterior margin is horizontal. The eighth tergum, on the other hand, is small and mostly concealed beneath the seventh tergum (fig. 84). The end of the eighth segment thus forms a cup-shaped cavity directed upward, into which is set the base of the hypopygium. The sternum bears posteriorly on each side a wide brush of hairs directed ventrally.

The hypopygium projects almost vertically from the eighth segment. It has in general the form of a frustum of a cone. There are well developed triangular pleural plates present. The halves of the sternum are fused below along their entire length. Posteriorly the sternal margin is emarginate. An elongate, club-shaped lobe (fig. 84, *a*) arises on each side from the margin of the sternum, lateral of the median notch, and projects posteriorly. The tergum is almost divided into two plates (fig. 86) by a deep notch on the posterior margin, and a still deeper one on the anterior. The two leave only a very narrow connecting bridge somewhat back of the centre.

There are three apical appendages on each side (fig. 85). The first (A) is the smallest, being slender, compressed and clavate. The second (B) is the largest. It is expanded distally and ends in a flat point directed forward. Its anterior edge bears the ordinary elongate elevation, ending with a free lobe above. The third (C) is entirely separated from the second. It is widest basally and tapers distally to a narrow elongate process abruptly bent posteriorly.

The central vesicle (fig. 88, *c. v.*) has the anterior arms rather slender, but the posterior arms and the apodemes are relatively large. The penis (*p.*) first goes downward and then turns forward to about the seventh segment. It then again goes posteriorly to below the central vesicle where it turns dorsally along the vertical floor of the genital chamber. The tip is curved anteriorly. The guard of the penis (fig. 87) consists of two high and relatively short plates united by their lower edges, and inclosing, thus, between them a deep trough-like space. From the lower posterior angle of each a long,

slender, blade like plate extends caudally, the two having their flat surfaces apposed and vertical. Below their bases there projects ventrally and posteriorly, from the ventral surface of the guard, a transverse, pointed, chitinous process.

Tipula inermis Doane (Pl. XIII, figs. 89, 90, 91, 92, 93).

The eighth sternum is large, prolonged posteriorly and armed at the posterior end. The posterior border of the sternum is deeply emarginate (fig. 92). At each side of the emargination is born a large, three-sided, conical lobe (*a*) attached by its apex, similar to that of *Tipula æqualis*. The flat bases of these lobes are turned upward and inward. The dorsal angles of the bases are connected by an arched bar of chitin lying in a membranous fold above. At the apex of the notch of the sternum is a wide, rounded, plate-like lobe (*b*) projecting posteriorly and ventrally. On each side of it there projects posteriorly a long arm-like process (*c*). From each inner ventral angle of the conical lobes (*a*) a pencil of hairs projects inward and posteriorly.

The hypopygium is somewhat flattened upon the end of the abdomen (fig. 91). The sternum is divided by a V-shaped notch almost to its anterior margin. In front of the apex of the emargination is a membranous area, and in front of this is a chitinous bar connecting the lateral chitinous parts. There is a submarginal suture along each side of the notch, and the two separate off a V-shaped marginal lobe. Each posterior end of the latter forms a small knob supporting a bunch of hairs. Laterad of this there is a hook-shaped appendage on each side arising from the sternal margin (fig. 91, *d*). There is a well developed triangular plate on each side, separated by an angular suture from the lateral part of the sternum.

There are three apical lobes, all of them arising from a common base (fig. 89). The first (*A*) is small, flat and spatulate. It arises from the anterior part of the base of the second. The first very commonly arises close to the base of the second, but it is seldom attached almost to the side of it as in this species. The second appendage (*B*) is large and flat. Distally it is expanded and produced into a blunt point posteriorly and a sharper one anteriorly. The anterior margin below the lobe is reflexed posteriorly over the outer side. The third appendage (*C*) is a short slender arm arising from the posterior edge of the base of the second.

The penis and central vesicle are ordinary. The guard of the penis is an elongate bar widened distally into a triangular plate, ending in a median point and two longer club shaped lateral arms. A median, dorsal groove runs along its entire length (fig. 93).

The anal tube is exceptionally large (fig. 90), being wide basally and very long, so that it projects far out of the genital chamber (fig. 91, *a. t.*).

Tipula bicornis (Pl. XIV. figs. 94, 95, 96, 97, 98, 99, 100, 101).

The eighth sternum is greatly elongated and produced posteriorly. The sides are convergent, but the end is truncate and bears a flat brush of long hairs.

The tergum of the hypopygium (fig. 101) is very long, widest at the base, slightly tapering distally. The posterior margin is notched mesially and on each side is produced into a tapering horn-like process, projecting outward and posteriorly. On account of the great length of the tergum the hypopygium is much longer above than it is below. Between the tergum and the pleurum on each side (fig. 94) is a wide triangular membranous area. From a point somewhat beyond the middle of each lateral margin of the tergum a chitinous band extends downward and posteriorly through the membrane just described and unites with the side of a small trapezoidal plate on the ventral wall of the anal tube (fig. 100).

The pleura are triangular plates distinct from the sternum. Each has a wide convex anterior edge. The other two edges are concave. From the upper angle there projects posteriorly and upwardly a sharp tapering process (fig. 94). This is simply a prolongation of the pleurum itself.

There are three apical appendages on each side (fig. 98). The first (A) is short, cylindrical and very slender. The second (B) is nearly twice as long as the first. It is an elongate stalk-like structure, with an enlarged, distally rounded, cap-like head. The third (C) arises from the posterior edge of the base of the second. It consists of a narrow basal peduncle, a triangular, flattened plate beyond this, and of a slender distal arm with a terminal enlargement.

Just below each pleurum there projects posteriorly from the sternum a small flattened truncated lobe (fig. 94). Each of these processes bears on its inner side a small appendage (fig. 96), which carries a bunch of long, spirally twisted hairs on a knob near its inner end.

The central vesicle (fig. 97) is hemispherical. Its posterior arms are long and slender, the anterior lateral lobes are large, wide, rounded plates. The penis is extremely slender, almost hair-like, and runs forward to the third abdominal segment before turning posteriorly.

The guard of the penis (fig. 95, *p. g.*) is an elongate pyriform structure with a median groove along the dorsal side. It is supported on a rather complicated framework of chitinous bars. A flat chitinous tongue like process, pointed distally, arises from the ventral side of the guard and projects posteriorly below it. The supporting framework alone is shown in figure 99; *a* is the ventral tongue of the guard with the latter removed from its proximal end. On each side there is a long plate bent into a right angle (*b*). One arm of each lies along the side of the guard, the other projects outward and downward from the distal end of the first. From the angle a tapering plate (*c*) runs posteriorly, inward and downward, and unites with the ventral tongue of the guard. The latter is connected in a similar manner with the middle of the longitudinal arm by a tapering bar (*d*). The guard itself is, thus, supported only by its ventral tongue, this being attached to the plates on each side by the two pairs of transverse connectives.

Tipula lamellata Doane (Pl. XII, figs. 73, 76, 77).

The eighth sternum is prolonged posteriorly beneath the hypopygium and bears at its truncated end two brushes of long hairs (fig. 77).

The tergum of the hypopygium has almost the shape of the capital letter A with the apex cut off (fig. 73). It consists of two narrow plates diverging widely posteriorly and connected near their middle by a transverse crescentic bar of chitin. The concave posterior border of this bar forms the posterior margin of the tergum. The area in front of it is membranous. The pleural plates are small. Each (fig. 77, *pl.*) has the appearance of being an appendage on the posterior rim of the sternum. It consists of a short wide basal part and a free tapering but blunt process projecting posteriorly. To the inner side of its base is attached the apical appendage.

There is only one apical appendage on each side and this is the second (fig. 76). It is a wide, flat plate arising from a narrow base but rapidly expanding distally. It bears a sharp-pointed projection

on the middle of its distal edge, and another longer and slenderer one on the anterior angle. The latter projection is covered basally on its outer side by a lateral lobe. This is the characteristic feature of the second appendage.

The guard of the penis is triangular in lateral view. The lateral parts are transversely continuous into each other below. There is thus formed between them a wide space in which the end of the penis lies normally. In the specimen from which figure 77 was drawn the end of the penis (*p.*) was projecting from the genital chamber. The posterior dorsal angles of the guard are swollen into large, pale, tumid, semi chitinous lobes. The guard arises just above the posterior edge of the sternum, which is deeply notched. The sides of the notch bear two pad like, chitinous lobes. In front of these there is a narrow membranous space extending forward to the anterior rim of the sternum, which consists of a slender, arched bar of chitin.

Tipula unieincta Doane (Pl. XV, figs. 109, 110, 111, 114).

The posterior segments of the abdomen form a thick club shaped enlargement. The eighth segment is the widest, and its posterior rim is horizontal. The exposed part of the ninth is hemispherical and sits upon the eighth like a ball in a socket. The eighth tergum is small, but the sternum is very large and projects posteriorly and upward behind the hypopygium (fig. 109). It ends in a small transverse lobe bearing a fringe of long hairs. There is a rather wide depressed area between this lobe and the posterior (*i. e.* ventral) face of the hypopygium. From the floor of this depression there project two lateral, conical elevations (fig. 109, *a*) each bearing a long, slender, curved, blade-like appendage (fig. 109, *b*), the two crossing each other mesially (fig. 114).

The plates of the hypopygium have ordinary forms. The posterior margin of the tergum is deeply and narrowly cleft. The part on each side is produced posteriorly as a large tapering process. The sternum consists of two large lateral plates connected only by a narrow anterior median bridge of chitin below. Back of this bridge is a wide membranous area whose posterior margin hangs downward as a free fold (fig. 109, *c*). The pleurum is distinct from the sternum on each side. It is triangular, with the distal apex produced into a blunt, tapering point.

There are three apical appendages (fig. 110). The first (A) is flat and expanded distally, contracted into a slender peduncle basally. The middle lobe (B) is a wide triangle with a thick basal stalk. On the outer side of the basal two thirds of its anterior edge is a reflected elevation of the margin. The third lobe (C) arises from the posterior edge of the base of the second. It is short, wide and triangular, but is attached by one side. It bears a fringe of very long hairs.

The central vesicle and penis are of ordinary forms. The guard of the penis (fig. 111, *p. g.*) is a simple, slightly decurved, tapering, stylet like process arising from the floor of the genital chamber just above the posterior end of the median membranous area of the sternum. Its upper surface bears a deep longitudinal groove. Just below its base there arise two large, heavy, chitinous appendages (fig. 111, *a*) projecting posteriorly and dorsally (upward and forward in actual position). A little beyond its middle each is abruptly thickened by a lobe like ventral swelling. Beyond this it tapers to a slender, slightly decurved point. Below the bases of this pair of appendages there arises a single median appendage. This one arises from two converging basal rami, is thick basally, tapering and decurved distally, and ends in a small, transverse, triangular, arrow-head-like plate. The structure of the guard and the appendages below it is, thus, very similar to that of *Tipula bisetosa* (cf. figs. 107 and 111). The apical appendages are also very similar (cf. figs. 104 and 110). The general external shape of the hypopygium, however, is different, and in *T. bisetosa* the pleural plates are not separated from the sternum (cf. figs. 106 and 109).

Tipula streptocera Doane (Pl. XIV, figs. 102, 103, 105).

The eighth sternum is very large, being high on the sides and greatly prolonged posteriorly beneath the hypopygium. The posterior margin bears two short, thick, articulated, clavate lobes normally directed upward (fig. 102, *a*). The eighth tergum is a very small, semi circular plate covering the base of the dorsal surface of the hypopygium.

The hypopygium itself is rather small and is irregularly globular. Its walls consist principally of two large lateral plates, which are the lateral parts of the sternum with, perhaps, the tergum united. The two plates are separated along the mid-dorsal line by a narrow

linear membranous area. The dorsal part of each plate is distinguished from the rest by an oblique suture that cuts off on each side a triangular marginal plate having the apex forward. The two dorsal plates thus formed may represent the tergum divided by a median line of membrane. Each plate makes a sort of step posteriorly by turning downward and then posteriorly again. The pleura are entirely separated from the lateral sternal plates. Each is somewhat reniform in shape, with the convex side posterior and prolonged into a long, sinuous, tapering arm (fig. 103). This is similar to the much smaller process on the pleurum of *Tipula lamellata* and of *T. uncinata*.

The apical appendages have an unusual shape (fig. 105). There is on each one large triangular lobe (B) attached by an angle which forms a thick peduncle. From its position and general shape this lobe would appear to be the middle appendage of the ordinary three. Arising from the outer side of its base are two much smaller lobes (A and C). Each is flattened and expanded distally, and the two have a common base. One is anterior and turns forward, the other posterior and turns backward. They may be the first and third appendages.

The central vesicle, penis and guard have ordinary forms. The V-shaped bar between the posterior arms and the central vesicle has the tips of its arms embracing the base of the anal tube.

Tipula spectabilis Doane (Pl. XVIII, figs. 156, 158, 159, 160, 161).

This is a large species, with a specially large hypopygium. The latter stands almost vertically upon the eighth segment (fig. 160). The eighth sternum is large and prolonged so far posteriorly that it projects for some distance back of the vertical sternum of the hypopygium. The posterior end of the eighth sternum is truncate and deeply notched. The part of the margin on each side of the notch forms a large, inward-turned flap bearing a large brush of long hairs.

The tergum of the hypopygium consists of two plates entirely separated by membrane along the mid-dorsal line (fig. 156). The anterior edge is widely emarginate. Posteriorly each plate of the tergum is produced into a lateral and a more median point, while from between the two plates there projects caudally a short tapering process which is grooved along its dorsal side.

The sternum consists of two lateral plates as in other species. But here they are united below by a posterior bridge of chitin as

well as by an anterior one (fig. 161). The posterior margin is notched and each side of the notch bears a transversely elongate lobe.

The pleura are separate from the sternum. Each consists basally of an ordinary triangular plate, but the posterior margin is prolonged into a long curved arm ending in a large spatulate expansion (fig. 160). In this character the species strongly resembles *Tipula streptocera*.

There is but one terminal appendage on each side, but it probably is composed of both the second and the third appendages (fig. 159). It consists of an anterior and a posterior part. The former (B) is a wide plate with a blunt anterior tip and reflexed anterior margin, so that there can be no doubt that it is the ordinary second appendage. The latter is a triangular lobe (C) on the posterior edge of the base of the other, and is partially divided into several finger-like lobes.

The guard of the penis (fig. 158) is a simple, decurved, tapering process with a wide groove above. In this groove are two elongate lamellæ inclosing the penis between them. Their posterior tips project from the groove, as a separate process, above the tip of the main part of the guard. The central vesicle and penis have ordinary forms.

Tipula dorsolineata Doane (Pl. XII, figs 72, 74, 75).

The terminal part of the abdomen is bent upward, but the hypopygium does not form an enlargement of it. The eighth segment is wider than the ninth, and both tergum and sternum are large. The tergum of the hypopygium is deeply emarginate posteriorly, and is separated from the sternum by a wide membranous suture (fig. 72). The sternum is almost entirely separated into two lateral plates by a deep, narrow, median notch occupied by membrane. A pleural sclerite is present as a rounded lobe on the upper posterior angle of each half of the sternum. There are three apical appendages on each side. The first is large and spatulate, bent posteriorly (figs. 72 and 74, A). The second and third arise from a common base. The second is an elongate cylindrical lobe with an enlarged head bearing a short hook (B). It is mostly concealed by the first. The third arises on the outer side of the base of the second and projects posteriorly. It is spoon-shaped, with the concavity inward.

The penis is unusually thick. In the ordinary condition it lies entirely within the genital chamber and reaches forward to the second abdominal segment. Figure 72 represents a specimen with the penis partly protruded. In this condition the anterior part of the bend lies in the fourth segment. The central vesicle is correspondingly small. The guard of the penis is a triangular plate (fig. 75), with two small lobes arising from its basal angles and converging above its base. With the base of the guard they form a collar like ring which surrounds the penis.

The anal tube is short, simple and strongly compressed.

Tipula spernax O. S. (Pl. XII, fig. 68).

The hypopygium has a simple form. The tergum and sternum are united. The latter is deeply cleft below by a narrow, median, seam-like, membranous line. There is a trace of a pleural suture present. On each side a line curves outward and upward from the notch in the sternum below and in front of the part corresponding with the pleurum of Group II. It has rather the appearance of a disappearing suture in this group, than of the suture characterizing Group I.

There are three apical appendages on each side (fig. 68). The first (A) is a wide, plain lobe, slightly convex outwardly and concave inwardly. The second (B) is wide at the base, rapidly tapering distally into a slender arm directed anteriorly. The third (C) has a large triangular base lying against the outer side of the base of the second. Distally it tapers into a slender arm abruptly bent forward.

GROUP III.

Neither pleural sutures nor pleural plates present.

It is conceivable that this may be a composite group. The lack of any pleural demarkation might be due either to the entire suppression of the pleural sutures of Group I, or to the obliteration of the sutures in front of the pleural plates of Group II. The species that fall into this division, however, are not primitive in other characters. For example, in several the entire hypopygial wall consists of one continuous plate. There are not only no separate pleural plates, but the tergum and sternum are fused. Hence, the species having the characters of this group are here placed together as representing the final evolution of the hypopygium in the genus *Tipula*.

In harmony with this view the genus *Ctenophora*, in which all the hypopygial plates are fused, follows *Tipula*.

Tipula fallax Loew (Pl. XVI, figs. 133, 135, 137, 138).

The hypopygium and the three segments preceding it form a large, oval, terminal enlargement of the abdomen, directed upward and posteriorly at an angle of about 45 degrees with the much slenderer part in front. The eighth sternum is very large and is produced posteriorly beneath the hypopygium. It tapers posteriorly to a truncate end where it bears three blunt, conical elevations, one median and two lateral, each of which is covered with a thick growth of short hair.

The hypopygium is unusually large through being greatly elongate (fig. 138). It resembles in an exaggerated degree the hypopygium of *Tipula truncorum*. The sides of the tergum are not fused with the sternum, and converge slightly posteriorly. The posterior margin is rounded. From beneath the margin, however, there projects downward a small, median, chitinous knob bearing a sharp slender tooth.

A ventral view of the hypopygium (fig. 135) shows clearly that it is constructed, with modifications, on the same plan as in *Tipula bella* (fig. 124) and *T. caloptera* (fig. 129). There is present anteriorly a large, shield-shaped, membranous area. Back of this area, however, there is a long continuously chitinous space intervening between the membranous area and the posterior notch of the sternum. This intervening chitinous space is evidently formed by the fusion of the edges of the narrow anterior part of the notch in other species. From its posterior margin there projects backward two long slender sinuous blade-like processes (fig. 135, *a*), each slightly curved upward at the tip.

There are no pleural sutures present in this species. The part of each lateral sternal plate corresponding with the pleurum is produced backward in a short, blunt point. Ventrad to this and close to the posterior margin is an oval, membranous fenestrum. From the sternal margin, ventrad to this, there arises a large appendage (figs. 135 and 138, *b*), consisting of a central body and three arms. One arm extends posteriorly and inward, the second inward, the third, which is much longer than the others, extends anteriorly and inward.

The apical appendages are simple (fig. 137). The dorsal one (A) is large and mostly conceals the others in a lateral view (fig. 138). The middle one (B) is densely chitinous and ends in a flat point. A lateral lobe projects over the outer edge from below. The lower appendage (C) is large, thick, fleshy and united basally with the second.

The apodemes of the central vesicle (fig. 133, *ap.*) are unusually long, being greatly larger than the anterior arms of the vesicle. The guard of the penis is a long, pointed, stylet-like structure, swollen at the base, grooved above. It arises from the floor of the genital chamber just above the bases of the long slender processes (*a*) that project from the edge of the sternum. The penis curves immediately downward from the central vesicle. In the specimen from which figure 138 was drawn it was projecting posteriorly from the hypopygium.

The anal tube has the usual form. A minute, chitinous tendon runs along its upper edge from the roof of the genital chamber.

Tipula illustris Doane (Pl. XII, figs. 61, 62, 63, 67).

The abdomen and hypopygium of this species have a very simple form externally. The eighth segment is cylindrical, with the sternum prolonged beneath the ninth.

The hypopygium is a simple cup set vertically upon the eighth segment, and may be mostly retracted within this segment. A longitudinal (vertical) suture on each side separates the tergum from the sternum (fig. 61). The sternum is continuous across the ventral aspect of the segment without any constriction (fig. 63). The pleura are fused with the sternum, and there are no pleural sutures.

There are only two apical appendages on each side. The first (figs. 61 and 62, A) is a conspicuous strap-like lobe rising vertically from the rim of the genital chamber but bent inward distally. The second appendage (fig. 62, B) is a wide irregularly triangular lobe with the two distal angles prolonged each into a long tapering horn-like process. This appendage is mostly concealed mesad of the first and within the genital chamber.

The penis and central vesicle have the ordinary form. The arms of the latter are rather short. The penis curves forward only into the posterior part of the eighth segment. The guard of the penis (fig. 67) has a wide, thick body which laterally bears two sharp lobes, and is mesially prolonged posteriorly into a slender tapering

process. A dorsal groove extending along this process and the body of the guard lodges the tip of the penis.

Tipula carinata Doane (Pl. XII, figs. 70, 71).

The tergum and sternum of the hypopygium are almost fused, the suture on each side being marked only by a faint, pale line. The sternum is widely and deeply notched below, but the anterior bridge of chitin is comparatively wide (fig. 70). The notch in the chitin is occupied by a membrane which forms also the posterior margin of the sternum. This membrane has a small median emargination on whose edges are two elongate chitinous plates.

There are only two apical appendages on each side (fig. 71). The first (A) is a slender slightly clavate lobe. The second (B) is thicker, bent forward, and has a flat, oblique distal end. A small lobe (C) on the outer edge of its base might be a rudimentary third appendage.

The guard of the penis is a slender tapering decurved structure, grooved above, and bearing two small points projecting downward and posteriorly from the base.

Tipula flavicans Fab. (Pl. XIV, fig. 108).

The eighth segment is simple, its sternum is but little produced beneath the hypopygium. The abdomen gradually thickens posteriorly from the fifth segment.

The hypopygium is large and its walls are circularly continuous, there being no division into tergum, sternum or pleura, and the sternum is undivided below. The tergum is about twice as long as the lateral sternal and pleural parts. Its posterior border presents a rounded concavity above. The posterior, free, lateral margins are produced caudally as two large rounded lobes with serrated margins; each is very convex outwardly and concave inwardly (fig. 108, *a*). From the posterior border of the sternum there projects caudally a wide, flat, semi-chitinous, median lobe (fig. 108, *b*) with a small rounded crest-like elevation proximally on its upper side.

There are three apical appendages. The first (fig. 108, A) is small and spatulate. The second (B) arises just posterior to the first. It is wide and strongly curved forward. The third (C) is situated considerably below the others, and is double, consisting of an outer and an inner lobe. Both are curved dorsally and forward, the outer is slender and cylindrical, the inner wide and flattened.

The anal tube arises from the anterior wall of the genital chamber just below the lower edges of the posterior lateral tergal lobes. These two lobes on the sides, the anal tube below, and the under side of the tergum above, enclose a distinct dorsal division of the genital chamber between them. A narrow rod of chitin extends across its roof between the anterior ends of the tergal lobes. From this bar there hangs downward in the chamber a free bifid chitinous rod.

The central vesicle is of the ordinary shape. It is so situated, however, that its posterior arms project ventrally, and its anterior end is dorsal. Hence, the penis curves first dorsally and anteriorly from it. The guard of the penis is a short, curved appendage, thick basally, slender and pointed terminally, and grooved lengthwise on its upper surface.

Tipula sulphurea Doane (Pl. XII, fig. 66).

The hypopygium is externally of very simple structure. There is no division between tergum, sternum or pleurum, nor is there a pleural suture. The sternum is deeply emarginate, but each edge of the V-notch carries a narrow lobe attached along its entire length. The tergal margin bears two small median darkly chitinous knobs.

There are two apical lobes on each side. The first is short, slender, cylindrical and curved upward (fig. 66, A). The second (B) is wide and flat. On its outer side a flat lobe covers its anterior edge basally. Near the centre of the inner face there arises an unciform process that projects inward.

The penis curves immediately downward and posteriorly from the central vesicle. The guard is simple and stylet-like, with a dorsal groove.

Genus **CTENOPHORA** Meigen.

In the structure of the hypopygium this genus scarcely differs from some of the species in Group III of *Tipula*. It is placed at the top of the family by systematists, and logically following the system by which the species of *Pachyrrhina* and *Tipula* have been arranged in this paper, it must be assigned this position if classified by the structure of its hypopygium.

Ctenophora angustipennis Loew (Pl. X, figs. 46, 47, 48, 49).

The eighth segment is high and comparatively short, but is not specially modified, nor is its sternum produced beneath the hypopygium.

The body of the hypopygium is entirely undivided into tergum, sternum or pleura (fig. 49). The tergal part is very short (fig. 47), while the sternal part is correspondingly very large. Through this disproportion between the dorsal and ventral surfaces the posterior rim is almost horizontal and the genital chamber opens upward. The tergal region bears on each side a large horn-like process (figs. 47 and 49, *a*), the two diverging posteriorly and laterally. The sternum has a deep median notch on the posterior margin, but is not otherwise divided.

There are three apical appendages on each side. The first (figs. 47 and 49, *A*) is a large plate, convex outwardly and concave inwardly, also bent in the latter direction, and expanded and notched terminally. The second (fig. 49, *B*, and fig. 46) has a plate like basal part, but distally it tapers into a long, slender, densely chitinous and somewhat spatulate arm directed anteriorly within the first appendage. The third appendage is slender and angularly bent forward. It lies within the second and is entirely concealed in the genital chamber.

The central vesicle, penis and guard have the forms characteristic of *Tipula*. The penis makes a short curve forward into the eighth segment. The guard is a simple, compressed structure, with a deep, narrow, slit like, median groove along the dorsal surface.

The anal tube is the same as in *Tipula*.

SUMMARY.

If we assume that the primitive Tipulid hypopygium consisted of a tergum above, a sternum below, and of a pleural plate on each side intervening along the whole length of the segment between the tergum and the sternum, then we must adopt the phylogenetic outline followed in this paper. Briefly summarized this is as follows: There are two groups of species that present a primitive arrangement of the hypopygial sclerites. The first consists of the genus *Antocha* and of the section Limnobina. The second consists of the section Ptychopterina which includes *Bittacomorpha* and *Ptychoptera*. All of these forms have the pleura in the typical position just described. From the first group have been derived a series of forms consisting of the Limnobina *Anomala*, except *Antocha* (but including *Rhamphidia* and *Dicranoptycha*), the Eriopterina (*Trimicra*, *Symplecta*, *Erioptera*), the Limnophilina (*Limnophila*, *Epiphragma*), the Anisomerina (*Eriocera*), and the Amalopina (*Amalopsis*). In this series the pleura have retracted from the anterior margin of the segment and have become exserted upon the posterior margin, appearing in most cases as appendages on the rim of the genital chamber. In *Antocha* and in the Limnobina (*Dicranomyia*, *Limnobia*) the apical appendages are born by the pleura, but, since these plates are here lateral, the appendages are on the hypopygial margin. In the forms with exserted pleura the apical appendages are, of course, born at the ends of the appendicular pleural lobes.

From the second primitively constructed group, represented by the Ptychopterina (which includes *Bittacomorpha* and *Ptychoptera*), is derivable the series formed by the Tipulina (*Pachyrrhina*, *Tipula*, *Ctenophora*). In some species of *Pachyrrhina* the pleura closely resemble the pleura in *Ptychoptera*, since they occupy the entire length of the side of the hypopygium. In most species of the genus, however, the anterior part of the suture between the pleurum and the sternum is obliterated. In many species its anterior end is bent upward for a very short distance at about the middle of the segment.

The lower members of *Tipula* resemble the higher forms of *Pachyrrhina* in having this "pleural suture" extending about half way to the anterior margin of the segment, and abruptly bent dorsally in a small terminal hook-like curve. In the majority of the

species of *Tipula* this short upward-bent arm of the suture is extended dorsally so as to cut off a small posterior plate behind it and above the horizontal arm. This plate always carries the apical appendages, and it may have its posterior angle produced into a long horn-like or spoon-shaped process. In the most modified members of the genus the suture between the pleurum and the sternum disappears entirely. Furthermore, in many of these the sutures separating the tergum from the lateral parts disappear so that the body of the hypopygium is entirely undivided into plates of any sort.

Ctenophora resembles these highest forms of *Tipula*, for the hypopygium has continuous walls showing neither tergal, sternal nor pleural sclerites.

In the introduction to this paper the author has disclaimed the notion that the plates called "pleura" are homologues of the lateral plates of the thorax. All that is here attempted is to show that an apparent homology can be traced between the lateral plates of the hypopygium in such genera as *Antocha*, *Dicranomyia*, *Ptychoptera*, etc., the large appendicular and appendage-bearing lobes of the hypopygium of *Dicranoptycha*, *Erioptera*, *Limnophila*, *Amalopsis*, etc., and the small posterior lateral plates of the hypopygium of *Tipula*. Since these plates or lobes primitively have a "pleural" position they have been called for convenience the *pleura*.

It may be imagined that the evolution has been in an opposite direction from that suggested. Starting with a small secondary plate cut off from each posterior upper angle of the sternum, we could imagine that the suture in front of it disappeared, and that the suture below it then extended forward until it separated off from the sternum a longitudinal plate between the ventral part of the sternum and the tergum, producing the forms thus characterized. By enlarging in the opposite direction this same small posterior plate could be easily transformed into an appendicular lobe, thus giving rise to the forms having this character. However, the fact, that following the line of the first assumption produces an arrangement of the genera almost identical with that followed by systematists using other characters for a guide, would seem to confirm the view adopted in this paper. The classification of the Tipulidæ by Osten Sacken in his Catalogue of North American Diptera is almost the same as would be a classification based on the hypopygium alone, if

we assume that the structure of this organ is most primitive in such genera as *Antocha*, *Dicranomyia* and *Limnobia*.

The variation of the internal features of the hypopygium is less important than that of the external. In all the genera below the Tipulina the penis is a straight, or slightly curved, tubular rod arising from the floor of the genital chamber and projecting straight backward. In the Tipulina it arises from the roof of the genital chamber. Its base is swollen to produce the central vesicle, while the rest is a slender, often hair-like tube curving anteriorly, ventrally and then posteriorly, making often a long loop forward. Its tip is in all cases protected by a guard. This latter structure is typically composed of two slender, longitudinal plates set close together on edge, with their lower margins united by membrane. In the lower genera often the entire penis lies in the groove of the guard. In the Tipulina it protects the tip when retracted, and guides the penis when being protruded. From above the base of the penis or the base of the guard, especially in the lower genera, there projects caudally a pair of arm-like processes which are often forked. If we count the guard as two processes, since it is so often composed of two slender plates united by their lower edges, then, with the dorsal pair, we have four processes arising about the base of the penis, one pair being above its base and the other below. It is evident that we may regard these structures as the homologues of the four *free* arms that arise about the base of the penis in a similar manner in some other Dipteran families. These have been termed the male gonapophyses, and so we may call the dorsal processes in the Tipulidæ the second or upper gonapophyses.

No attempt has been made in this paper to speculate upon the function of the parts of the hypopygium, or upon the cause of their evolution into such varied forms. The latter would afford a most interesting field for investigation. With all the striking diversification of the male parts, there is almost no variation in the genital parts of the females. Throughout the entire family the females present one type of structure,* of which there is but little modification, and certainly none to correspond with the great variety of specific differences found in the genitalia of the males.

* Journal N. Y. Entom. Soc. *Terminal segments of female Tipulidæ* (MS.) R. E. Snodgrass.

EXPLANATION OF THE PLATES.

EXPLANATION OF THE LETTERING.

The letters *a*, *b*, *c*, etc., are repeated on different figures to refer to miscellaneous structures that have no definite names and which are described in the text. The other symbols used are abbreviations, and are explained in the following :—*an.*, anus; *ap.*, apodeme; *ap.*, apical appendage; *ap. aps.*, apical appendages; *a. t.*, anal tube; *br.*, V-shaped brace between the posterior arms of the central vesicle; *c. v.*, central vesicle; *ej. d.*, ejaculatory duct; *g. c.*, genital chamber; *gon. 2*, second gonapophyses; *p.*, penis; *p. g.*, guard of penis; *pl.*, pleurum; *r.*, rectum; *s.*, sternum; *t.*, tergum; *A*, first apical appendage; *B*, second apical appendage; *C*, third apical appendage; *H*, hypopygium; VII, VIII, IX, seventh, eighth and ninth abdominal segments.

EXPLANATION OF THE FIGURES.

PLATE VIII.

- Fig. 1. *Dicranomyia venusta*, lateral view of terminal part of abdomen.
 “ 2. “ *longipennis*, guard of penis (*p. g.*) and second gonapophyses (*gon. 2*), left view.
 “ 3. *Antocha* sp. ?, penis, dorsal view.
 “ 4. *Dicranomyia longipennis*, terminal part of abdomen, dorsal view.
 “ 5. *Antocha opalizans*, terminal half of abdomen, lateral view, x 25.
 “ 6. *Antocha* sp. ?, guard of penis, dorsal view.
 “ 7. “ sp. ?, second gonapophyses of left side, lateral view.
 “ 8. “ *opalizans*, guard of penis, dorsal view.
 “ 9. *Trimicra anomala*, terminal part of abdomen, dorsal view.
 “ 10. *Symplecta punctipennis*, second gonapophyses and their apodemes (*ap.*), dorsal view.
 “ 11. *Antocha opalizans*, second gonapophyses of left side, lateral view.
 “ 12. *Symplecta punctipennis*, terminal part of abdomen, dorsal view.

PLATE IX.

- Fig. 13. *Epiphragma forcipennis*, distal half of abdomen, lateral view, x 20.
 " 14. *Limnophila cubitalis*, terminal half of abdomen, lateral view.
 " 15. *Epiphragma forcipennis*, second gonapophyses of left side and its apodeme (*ap.*) lateral view.
 " 16. *Limnobia sciophila*, terminal part of abdomen, lateral view, x 22½.
 " 17. *Limnophila rufibasis*, guard of penis, left side, showing position of penis (*p.*) within.
 " 18. *Limnophila quadrata*, terminal part of abdomen, dorsal view, x 25.
 " 19. *Limnobia sciophila*, apical appendage of hypopygium.
 " 20. " " guard of penis (*p. g.*) and second gonapophyses (*gon. 2*), ventral view.
 " 21. *Limnophila rufibasis*, base of penis, dorsal view.
 " 22. " " left apical appendage of hypopygium, lateral view.
 " 23. " " terminal part of abdomen, dorsal view, x 18.
 " 24. *Amalopsis constans*, sternum, ventral view.
 " 25. *Limnophila rufibasis*, second gonapophyses of left side.
 " 26. *Amalopsis constans*, dorsal view of hypopygium with appendages removed.
 " 27. " *ampla*, left apical appendage of hypopygium, lateral view.
 " 28. " " sternum of hypopygium, ventral view.
 " 29. " " tergum of hypopygium, dorsal view.
 " 30. " " terminal part of abdomen, lateral view, x 15.
 " 31. " *constans*, left apical appendage of hypopygium, inner view.
 " 32. " " terminal part of abdomen, lateral view, x 15.

PLATE X.

- Fig. 33. *Limnobia sciophila*, terminal part of abdomen, dorsal view, x 25.
 " 34. *Limnophila quadrata*, guard of penis (*p. g.*) and second gonapophyses of left side (*gon. 2*) with its apodeme (*ap.*), left view.
 " 35. *Bittacomorpha clavipes*, hypopygium, left side; *m*, intersegmental membrane between eighth segment and hypopygium.
 " 36. *Bittacomorpha clavipes*, guard of penis with penis projecting, dorsal view.
 " 37. " " tergum of hypopygium, dorsal view.
 " 38. " " sternum of hypopygium, ventral view.
 " 39. " " left pleurum of hypopygium with base of apical appendage attached (*ap. ap.*) and dorsal transverse process.
 " 40. *Ptychoptera lenis*, terminal part of abdomen, lateral view.
 " 41. " " tergum of hypopygium, dorsal view.
 " 42. " " penis, dorsal view.
 " 43. *Ctenophora angustipennis*, left lower apical appendage of hypopygium, external view.
 " 44. *Ptychoptera lenis*, left sternal lobe of hypopygium, lateral view.
 " 45. " " left apical appendage of hypopygium, lateral view.
 " 46. *Ctenophora angustipennis*, left middle apical appendage of hypopygium, lateral view.
 " 47. *Ctenophora angustipennis*, hypopygium, dorsal view.
 " 48. " " guard of penis, left view.
 " 49. " " terminal part of abdomen, lateral view, x 10.

PLATE XI.

- Fig. 50. *Pachyrrhina polymera*, apical appendages of left side, outer view.
 " 51. " *lugens*, terminal half of abdomen, lateral view.
 " 52. " *incurva*, central vesicle (*c. v.*), penis (*p.*) and guard of penis (*p. g.*), left view.
 " 53. *Pachyrrhina incurva*, terminal part of abdomen, lateral view.
 " 54. " *lugens*, apical appendages of left side, outer view.
 " 55. " *ferruginea*, guard of penis (*p. g.*) and second gonapophyses (*gon. 2*) with their apodemes (*ap.*), dorsal view.
 " 56. *Pachyrrhina ferruginea*, hypopygium, left view; *m*, intersegmental membrane between eighth segment and hypopygium.
 " 57. *Pachyrrhina pedunculata*, central vesicle (*c. v.*), penis (*p.*) and guard of penis (*p. g.*), left view.
 " 58. *Pachyrrhina pedunculata*, apical appendages of left side, outer view.
 " 59. " " apical half of abdomen, lateral view.
 " 60. " *polymera*, terminal part of abdomen, lateral view.

PLATE XII.

- Fig. 61. *Tipula illustris*, distal half of abdomen, lateral view, x 18.
 " 62. " " apical appendages of left side, outer view.
 " 63. " " ventral view of hypopygium.
 " 64. " *fumosa*, terminal part of abdomen, lateral view, x 20.
 " 65. " " apical appendages of left side, outer view.
 " 66. " *sulphurea*, apical appendages of left side, outer view.
 " 67. " *illustris*, guard of penis, dorsal view.
 " 68. " *spernax*, apical appendages of left side, outer view.
 " 69. " *brevicollis*, sternum and pleural plates of hypopygium, ventral view.
 " 70. " *carinata*, hypopygium with appendages removed, ventral view.
 " 71. " " apical appendages of left side, outer view.
 " 72. " *dorsolineata*, terminal part of abdomen, lateral view, x 15; *p.* penis projecting from genital chamber.
 " 73. " *lamellata*, tergum of hypopygium, dorsal view.
 " 74. " *dorsolineata*, apical appendages of left side, outer view.
 " 75. " " guard of penis, dorsal view.
 " 76. " *lamellata*, apical appendage of left side, outer view.
 " 77. " " apical half of abdomen, lateral view, x 10.

PLATE XIII.

- Fig. 78. *Tipula æqualis*, distal half of abdomen, lateral view, x 15.
 " 79. " " apical appendages of left side, outer view.
 " 80. " *cineracea*, terminal part of abdomen, lateral view, x 15.
 " 81. " " guard of penis, dorsal view.
 " 82. " *cineracea*, guard of penis, lateral view.
 " 83. " " apical appendages of left side, outer view.

- Fig. 84. *Tipula retusa*, terminal part of abdomen, lateral view, x 10.
 " 85. " " apical appendages of left side, outer view.
 " 86. " " tergum of hypopygium, dorsal view.
 " 87. " " guard of penis, lateral view.
 " 88. " " central vesicle (c. v.) and penis (p.).
 " 89. " *inermis*, apical appendages of left side, outer view.
 " 90. " " anal tube, or tenth segment.
 " 91. " " distal half of abdomen, lateral view, x 10.
 " 92. " " sternum of eighth segment, ventral view.
 " 93. " " guard of penis, dorsal view.
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PLATE XIV.

- Fig. 94. *Tipula bicornis*, distal half of abdomen, lateral view, x 10.
 " 95. " " guard of penis (p. g.) and supporting framework.
 " 96. " " lateral lobe of ninth sternum.
 " 97. " " central vesicle (c. v.) and base of penis (p.) ventral view.
 " 98. " " apical appendages of left side, outer view.
 " 99. " " guard of penis (p. g.) and its supporting framework.
 " 100. " " ventral plate of anal tube.
 " 101. " " tergum of hypopygium, dorsal view.
 " 102. " *streptocera*, hypopygium, dorsal view.
 " 103. " " terminal part of abdomen, lateral view, x 10.
 " 104. " *bisetosa*, apical appendages of left side, outer view.
 " 105. " *streptocera*, apical appendages of left side, outer view.
 " 106. " *bisetosa*, distal half of abdomen, lateral view, x 10.
 " 107. " " guard of penis (p. g.) and appendages below it.
 " 108. " *flavicans*, distal half of abdomen, lateral view, x 10.
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PLATE XV.

- Fig. 109. *Tipula uncinata*, distal half of abdomen, lateral view, x 10.
 " 110. " " apical appendages of left side, outer view.
 " 111. " " guard of penis (p. g.) and appendages below it.
 " 112. " *acuta*, apical appendages of left side, outer view.
 " 113. " " eighth sternum of abdomen, ventral view.
 " 114. " *uncinata*, posterior end of eighth abdominal sternum, anterior (i. e. dorsal) view.
 " 115. " *acuta*, ventral appendages of ninth abdominal sternum.
 " 116. " " guard of penis, dorsal view.
 " 117. " " tergum of hypopygium, dorsal view.
 " 118. " *tephrocephala*, terminal part of abdomen, lateral view, x 10.
 " 119. " *tricolor*, terminal part of abdomen, lateral view, x 10.
 " 120. " *tephrocephala*, tergum of hypopygium, dorsal view.
 " 121. " *tricolor*, apical appendages of left side, outer view.
 " 122. " *tephrocephala*, apical appendages of left side, outer view.

PLATE XVI.

- Fig. 123. *Tipula bella*, terminal part of abdomen, lateral view, x 23.
 " 124. " " ventral view of hypopygium with appendages removed.
 " 125. " " central vesicle (*c. v.*) and penis (*p.*), left view.
 " 126. " " guard of penis (*p. g.*) and appendages attached to its base.
 " 127. " " apical appendages of left side, outer view.
 " 128. " *caloptera*, distal half of abdomen, lateral view, x 10.
 " 129. " " ventral view of hypopygium with appendages removed.
 " 130. " " dorsal view of hypopygium.
 " 131. " " guard of penis (*p. g.*) and attached appendages.
 " 132. " *truncorum*, terminal part of abdomen, lateral view, x 10.
 " 133. " *fallax*, central vesicle (*c. v.*) and basal part of penis (*p.*).
 " 134. " *truncorum*, apical appendages of left side, outer view.
 " 135. " *fallax*, ventral view of hypopygium.
 " 136. " *incisa*, apical appendages of left side, outer view.
 " 137. " *fallax*, apical appendages of left side, outer view.
 " 138. " " distal half of abdomen, lateral view, x 10.

PLATE XVII.

- Fig. 139. *Tipula angustipennis*, abdomen, lateral view, x 5.
 " 140. " " middle and lower apical appendages, outer view.
 " 141. " " dorsal view of hypopygium.
 " 142. " " lateral view of hypopygium.
 " 143. " " upper apical appendage of left side, outer view.
 " 144. " " central vesicle (*c. v.*) and penis (*p.*), left side.
 " 145. " " guard of penis, dorsal view.
 " 146. " " central vesicle (*c. v.*) and penis (*p.*), ventral view.
 " 147. " " ventral view of hypopygium.
 " 148. " " v-shaped bar in roof of genital chamber lying between posterior arms of central vesicle.
 Fig. 149. *Tipula angustipennis*, terminal part of abdomen, lateral view, with left side of eighth and ninth segments removed, x 15; *an.*, anus; *a. t.*, anal tube or tenth segment; *c. v.*, central vesicle; *ej. d.*, ejaculatory duct; *g. c.*, genital chamber; *p.*, penis; *p. g.*, guard of penis; *r.*, rectum.

PLATE XVIII.

- Fig. 150. *Tipula trivitta*, central vesicle (c. v.) and penis (p.), left side.
" 151. " " guard of penis, left side.
" 152. " " ventral view of bent bar lying between posterior arms
of central vesicle.
" 153. *Tipula trivitta*, apical appendages of left side, outer view.
" 154. " *cognata*, left view of hypopygium; *m*, intersegmental membrane
between eighth segment and hypopygium.
" 155. *Tipula cognata*, ventral view of hypopygium with appendages removed.
" 156. " *spectabilis*, tergum of hypopygium, dorsal view.
" 157. " *cognata*, apical appendages of left side, outer view.
" 158. " *spectabilis*, guard of penis, left side.
" 159. " " apical appendage of left side, outer view.
" 160. " " distal half of abdomen, lateral view, x 10.
" 161. " " ventral view of hypopygium.





















